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ABSTRACT

This study was designed to identify the factors that relate to the decisions of females in secondary education to elect or decline advanced instruction in mathematics. The final sample included 91 classrooms in 11 high schools, with the focus of the investigation upon 489 students in 22 geometry classes. The findings indicate that the most important factors influencing women's decisions to enroll in advanced mathematics classes are parents' encouragement and support, students' successful experiences in mathematics classes, spatial ability in mathematics aptitude, and career plans. While teachers were found to interact more often with male pupils than with females, this factor did not seem to influence women's decisions regarding enrollment in advanced mathematics. It was found in one of the schools studied that a program designed to give all students many opportunities to see the educational and career opportunities involved in becoming a physicist, architect, or engineer appears to have influenced enrollment by both sexes in advanced mathematics. This school had a greater percentage of students enrolled in such classes than any of the others studied. The report contains further analysis of the findings and samples of some of the survey instruments used. (MP)

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FACTORS INFLUENCING WOMEN'S DECISIONS TO ENROLL IN ADVANCED MATHEMATICS COURSES

Final Report

May 1979

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

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MAJOR FINDINGS

- Women students are more likely to enroll in advanced mathematics if they receive support and encouragement from their parents to take mathematics.
- Women students are more likely to enroll in advanced mathematics classes if their previous experiences in mathematics have been positive, e.g., they liked the subject, found it easy, and received good grades.
- Women students are more likely to enroll in advanced mathematics classes if they test high on mathematics achievement tests and spatial ability tests and if it is required in their career plans..
- Men did not score consistently higher than women on mathematics tests or spatial ability tests when each mathematics course is considered individually; men scored higher than women on tests in calculus and analytic geometry, but not in trigonometry or algebra II.
- Women were more likely to enroll in advanced mathematics classes if their geometry teacher provided interactive instruction and ample feedback to both men and women students.
- School counseling and career education programs had little effect on women's decisions regarding enrollment in advanced mathematics classes; however, a mathematics intervention program at one school contributed to a greater awareness of math-related careers.
- The highest percentage of women enrolled in advanced mathematics classes was found in two inner-city, predominantly Black schools.

EXECUTIVE SUMMARY

The purpose of the SRI Women and Math study, funded by the National Institute of Education, is to identify factors related to high school women's decisions to enroll or not to enroll in advanced math classes.

The study was carried out in 11 San Francisco Bay Area schools. These schools were selected from telephone survey information collected from 130 public and private high schools. Selection criteria were based upon the sample design, which required two urban schools with a high percentage of women enrolled in advanced math classes and two urban schools with a low percentage of women enrolled in these classes. From a suburban population we also selected two high schools with high women's enrollment in advanced math and two schools with low enrollment. In addition to these eight schools that completed the design, three other suburban schools were included when the superintendent of a neighboring district requested participation for their three high schools at their district's expense.

The final sample included 91 classrooms in 11 high schools. The classrooms were sorted into three types:

- Type I included general math and pre-algebra, required for high school graduation.
- Type II included algebra I and geometry, required for entry into the California university system.
- Type III included trigonometry, algebra II, calculus, required for entry into some university science and math programs.

Within these 91 classes, approximately 2100 students were given questionnaires, interviews, instruction rating scales, an achievement test and special ability tests. Seventy-six teachers were observed and given questionnaires. To study the broader school program, counselors were given questionnaires and administrators and career personnel were interviewed.

The focus of the study was upon the 489 students in the 22 geometry classes in the 11 schools. Below this level women choosing to take

algebra I and geometry most likely did so in order to be able to enroll in the California University system. We found the number of men and women enrolled in Type II classes to be approximately the same. Of those, 78% of the women were enrolled in the next semester's advanced math class while 89% of the men were enrolled. Thus, the interesting question became why some women who had completed geometry decided to continue their studies in mathematics while others did not.

Five hypotheses were generated to study this question. They are as follows:

- (1) Factors (parents, peers, teachers, counselors, programs, potential careers or college plans) identified by students as most influential in their decision to enroll or not to enroll in an elective math class will be identified and they will vary by school, location and by high and low involvement of women in advanced math classes.
- (2) A positive relationship will be found between math aptitude and ability and decisions to continue in advanced math classes; further, that men and women enrolled in advanced math classes will have similar achievement scores.
- (3) Particular combinations of classroom processes will be related to high enrollment of women in math classes.
- (4) Differential treatment of men and women students will be observed in math classrooms and this will be related to enrollment in advanced math classes.
- (5) Schools in which women students are exposed to math-related programs or career education programs will have a higher enrollment of women in math classes than will schools without such interventions.

Hypothesis #1: Comparison of Women Who Continue
in Mathematics and Those Who Do Not

Hypothesis #1 was tested by conducting discriminant function analyses and analyses of variance that compared the student questionnaire responses of groups of women choosing to take advanced mathematics with those choosing not to take advanced mathematics. The 189 women continuing with math studies were compared with the 42 who were not. Variables were used from the student questionnaire, Student Rating Scale of Instructors, space relationships test, and the geometry achievement test. Student interviews were used to document in more detail possible school influences.

The factors from the student questionnaire, student ratings and test data that are found most often to differentiate the women continuing in mathematics from those who are not are parent expectations and parent support in taking advanced mathematics. Prior research suggested that parental encouragement of women to enroll in advanced math classes is crucial but often absent (Aiken, 1972a; Haven, 1971; Fennema and Sherman, 1977a). Our data suggest that parents are perhaps the most important factor for women as well as men in continuing with math studies.

Overall women continuing did rate their math teachers as being more professional than did those not continuing, but they also said they would take a class from a teacher they didn't like. However, teacher influence was not one of the most highly rated influences on student decisions to continue in math studies. Nor did women students credit peers, counselors, or school programs as important in effecting their math enrollment decisions.

Women who were continuing in math studies had more spatial ability, high achievement test scores, more positive feelings about mathematics, and less anxiety. Thus, we must conclude that attitude and aptitude are factors in women's continuing math studies.

Other researchers have reported that women tend to underestimate their intellectual abilities and lack self-confidence, resulting in math anxiety (Ernest, 1976; Levine, 1976). However, the women in this study who continue in math studies reported that they like mathematics, they are good at it, and it is necessary for careers they have chosen. This population of women responded differently than those described by Ernest, 1976; Fennema and Sherman, 1977b. They do not perceive mathematics as a male domain.

Hypothesis #2: Difference Between Women's and Men's Math Aptitude and Achievement in Advanced Math Classes

The second hypothesis stated that a positive relationship would be found between math aptitude and ability and decisions to continue in advanced math classes; further, that men and women enrolled in advanced math classes would have similar math aptitude and achievement scores.

To examine the relationship between math aptitude and math achievement, Pierson Product Moment correlations were computed for each level of math test and the space relationships test. There are significant correlations for men and women between spatial ability and math achievement above the level of arithmetic. There are significant correlations for women at all levels but curiously not for men in either algebra II or calculus.

Men scored higher than women on the achievement tests and space relationships test on all levels except trigonometry and algebra II. It must be remembered that with such a large number of students in the sample very small differences of one or two test items may result in significant differences that have little actual meaning.

The second hypothesis was confirmed in part. There are relationships between spatial ability and math achievement. Similar to the findings of Fennema (1974) and Maccoby and Jacklin (1974) we found men in general to score higher on the space relationships test but not at all levels of testing. We also find that women continuing in math studies scored higher on the space relationships test than did women who did not continue.

We found no difference in achievement scores of men and women in algebra II and trigonometry, but men scored higher in analytical geometry and calculus. This supports the findings of Sherman and Fennema (1977) that men are not invariably superior in math achievement and spatial visualization when the math courses taken are considered.

Hypothesis #3: Classroom Processes Related to Enrollment of Women in Advanced Math Classes

Hypothesis #3 states that particular combinations of classroom processes will be related to high enrollment of women in math classes. To examine this hypothesis we correlated 34 observation variables with women's enrollment in advanced math classes. We focused on the relationship between classroom process variables and the continuation rate for women in the different geometry classes. Nine categories of classrooms were defined based on the percentage of women continuing from geometry into advanced math classes, ranging from 45% to 100%. Only four significant correlations were identified. They are so few that they could be spurious correlations.

It does appear that women continue to enroll in mathematics when they are in classrooms that are interactive and instructive. It doesn't matter whether this interaction occurs more with men or women students. It does seem important that an active instructional environment is established. The classroom with the lowest percentage of women continuing had the most discipline problems and the most social interactions. This indicates more time spent off the task of instructing mathematics. Interestingly, fewer males also continued with math studies from that class. There is little in the literature from previous studies that either substantiates or conflicts with these findings.

Hypothesis #4: Differential Treatment of Men and Women in Math Classes

Hypothesis #4 stated that differential treatment of men and women students would be observed in math classrooms and this will be related to enrollment in advanced math classes. To study this hypothesis we used observation data and statements of teachers on the teacher questionnaires.

Observation

Since geometry classes are the focus of this analysis, only Type II classes (algebra I, geometry) were examined here. There are approximately 50% women in Type II classes. Therefore, the number of interactions with men and women should be about equal if equal treatment is being given.

Though few of the differences are significant, the trend is rather clear. Men are spoken to more often than are women. Men ask more questions and teachers ask men more questions. Women volunteer answers as often as do men but the men are called upon to respond more frequently than are women. Men receive a little more individual instruction and social interaction. Acknowledgement, praise, encouragement and corrective feedback are given slightly more frequently to men than to women.

The only variable that occurs more frequently with women is positive interactions. Teachers smile or laugh more often with women students than they do with men.

Teacher Questionnaire

To see whether teachers perceived differences in the behavior of women or men students and to see whether we could detect any sex bias on the part of teachers, we arranged the 22 geometry classes into nine categories. These categories of classrooms were based upon the percentage of women continuing from geometry into advanced math classes, ranging from 45% to 100%.

The nine geometry teachers who had had 89% or more of their women students enrolled in advanced math classes reported that more women than men requested advice about continuing in math studies and that the women students' parents met more often with teachers. The four teachers with fewer than 65% women continuing in mathematics reported that men requested such advice more often than women, and that the parents of men met more often with the teachers than did the parents of the women students.

All 22 teachers felt that men and women were equally good at mathematics and that men and women did not differ in spatial ability. Most of the teachers tended to feel that family, college, or career plans had about equal influence on women's and men's decisions to take advanced mathematics.

Hypothesis #4 is confirmed in part by the observation data. Overall, men students are treated somewhat differently than are women students in geometry classes. This is in agreement with Bean's findings (1976) that showed teachers initiating more contacts with men students than with women students and with Dweck and Repucci (1973) who suggest that math teachers provide more feedback to men. Although we found such differences, they did not relate to the enrollment of women in advanced math classes. As stated in Hypothesis #3 discussion, women were more likely to enroll in classes where the instruction provided was actively interactive regardless of whether the introduction was with men or women.

The responses of teachers on the questionnaires did not indicate any teacher bias. They reported women to be equally good at mathematics as men and that they should be prepared in the same way as men for colleges and careers. This is different than Ernest's finding (1976) that 41% of math teachers felt men did better than women while none felt women did better than men.

Hypothesis #5: Mathematics Related School Program
and Counselor Advice

Hypothesis #5 states that schools in which women students are exposed to math-related programs or career education programs will have a higher enrollment of women in math classes than will schools without such intervention. To study this question we interviewed school administrators and career education personnel. Counselor questionnaires also provided information about the influence of the school environment.

All schools in our sample had some sort of career education program for their students. The degree of formality of this program varied from school to school, and primarily between urban and suburban schools. In most of the urban schools (3 of the 4 in our sample), career education seems to be given low priority. Career centers were given a small amount of space and were run by a technician or a counselor who also had numerous other responsibilities within the school. Those in charge of the career education programs reported that communication from the administration and the math department to the career centers is generally limited. Only one urban school reported an active recruitment for their math program. This program receives support from the business community and students are exposed to a wide range of math-related career options. The program does not necessarily encourage women to enroll in math any more than it does men, but this is the school with the highest enrollment of women students in advanced math classes.

In the suburban schools, the picture was somewhat different. Career planning was seen as more important; there was only one suburban school in our sample that stressed college attendance per se over career planning. Career planning in the suburban schools seems to receive more space, a full-time counselor, and better communication with the administration and the math department. However, none of the suburban schools reported active recruitment of women into the math program; nor did they report having programs to encourage women to increase the range of their career choices.

Since there were so few active career education or math programs in our sample of schools, we cannot confirm the hypothesis that relates

high involvement of women in advanced mathematics to school career programs--except in one school. The reason for the higher involvement of women in this urban school may be that these young women, having entered the math program, continue taking mathematics because they do not have the mother role model suburban women have. In suburbia, mothers are likely to have college degrees in liberal arts or social sciences, and if young suburban women follow in their mother's model they do not need advanced mathematics. The young urban woman achieving well in mathematics can aspire to be a doctor, an architect, or physicist since she may be the first in her family to go to college--she creates her own model.

Fifty-three counselor questionnaires were returned. None of the counselors reported giving different career plan advice to men than to women. They reported that overall women sought more advice than men. They felt that previous grades in mathematics and the advice of math teachers and parents influenced men and women students the most in making decisions to continue in math studies.

The findings from the counselor questionnaires are different from those reported by Casserly (1975) and Luchins (1976). These researchers reported that some counselors admitted discouraging women students from taking advanced math courses. The counselors in our study made no such admissions. It may be that counselors' stereotyped attitudes are decreasing toward the end of this decade.

Implications and Recommendations

Our findings indicate that the most important factors influencing women's decisions to enroll in advanced math classes are parents' encouragement and support, students' successful experiences in math classes, spatial ability in math aptitude, and career plans.

These data suggest that parents should be informed of the importance of their influence upon students' decisions to take advanced mathematics. This finding is somewhat surprising in that secondary students tend to try to establish their own values and life styles and many verbally reject parental influence. Nonetheless, at some crucial level parents do affect

student decisions through their support and recognition that math studies are important to mental development and as an entrance to some careers.

Students' spatial ability correlated with math achievement. Women students with higher spatial ability and math achievement tended to be the ones who continued in math studies. The students who said they are good at mathematics are the same ones who tended to score high on the space relationships and on math achievement tests. This relationship was similar for men and women, although men scored slightly higher than women on the space relationships test.

Teachers were found to interact more often with men students than with women students. However, this fact did not seem to influence women's decisions regarding enrollment in advanced mathematics. The classroom processes that did relate to re-enrollment concerned an active instruction involvement of teachers with students whether they were men or women. The continuation of math studies was lowest in classrooms where more disciplining occurred and where there were more written assignments and less instruction. This suggests that teachers should be actively involved with students, providing instruction, questions, and feedback.

The study findings also suggest that the counseling programs and career education programs offered at these 11 schools have very little influence on women's decisions to enroll in advanced math classes. Since the women taking geometry in this study appear to have already formulated their career plans, it seems that junior high schools as well as high schools should provide career education programs that expose young women to a wide range of career option experiences. Women may too quickly choose sex stereotyped careers if such exposure does not occur.

In one school, where women and men students are given many opportunities to see what it means to be a physicist, architect, or engineer through a math, engineering, and science association, a high percentage of women are enrolled in advanced math classes. This is the only functioning school program that appears to have an effect on student enrollment in advanced mathematics. This small urban school has a greater percentage of men and women students enrolled in advanced mathematics than do the other 10 high schools in this sample.

In conclusion, this study provides evidence that enrollment in advanced math classes is related to certain student abilities. While parents can be encouraged to support their children to take advanced mathematics and school career education programs can expose young women to a wider range of career choices, spatial ability may be sex-linked and not so amenable to change. However, the differences in the test scores of men and women were slight and the important idea here is to make able women and men students aware of their own potential and more aware of the career doors that are open to those who achieve in advanced mathematics.

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We are especially grateful for the cooperation of the school administrators and career education and counseling personnel who gave generously of their time and provided us with rich background information on each of the eleven schools in our study.

Finally, our heartfelt thanks are expressed to the many teachers and students who made the study possible by responding to our questionnaire, interview, and test items. Their interest in the study findings and the discussions of how teaching can be improved have been mutually informative and valuable.

I INTRODUCTION

Recognizing that women historically have been underenrolled in advanced math classes and thus underrepresented in math-related occupations, SRI International has carried out a study to examine factors that influence women's decisions to take advanced math classes.

The study was funded by the National Institute of Education in a program of research to illuminate relationships between women and their involvement in mathematics. SRI was one of 10 organizations funded to conduct research under this program.

The primary focus of SRI's Women and Math study was to identify factors that promote higher enrollment and encourage more positive attitudes toward mathematics among high school women. Specifically, the study was designed to (1) identify major personal, social, and school-related factors that influence student decisions to enroll in advanced math courses and (2) to identify math programs or career education programs that promote high enrollment of women in math courses. All of these factors were investigated as possible determinants of student attitudes, perceived utility of mathematics, and future enrollment in math courses. Data were collected from 11 schools (four urban and seven suburban). Over 2100 math students, 76 teachers in 91 classrooms, and 53 counselors in the Bay Area participated in the study.

The schools selected represent both urban and suburban schools with high, medium, and low enrollment of women in advanced math classes. Through our design and observation methodology, some classroom instructional processes that are used differently with men and women have been identified. Through questionnaires and interviews we examined how women's decisions regarding enrollment in math classes are influenced by peers, parents, teachers, and counselors. The effect of career education and math programs on women's career decisions also was assessed.

The following section describes the problem and presents a review of the related research. The design and study questions, as well as sample selection and instrumentation are included in Section III. Data collection comprises Section IV; followed by a description of the analyses and findings in Section V. Section VI offers implications of the findings and recommendations. The feedback offered to teachers who took part in the study is detailed in Section VII.

II STATEMENT OF THE PROBLEM AND REVIEW OF RELATED RESEARCH

Statement of the Problem

Women account for 49% of the secondary school population in the United States, but comprise only 20% of high school students taking courses in advanced mathematics. Furthermore, while women comprise 45% of the total college and university population, they constitute only about 30% of the college and university students receiving Bachelor degrees in mathematics. The underrepresentation of women in advanced math courses is significant in its own right and suggestive of a problem. When considered in the context of occupational data, the facts pertaining to women's nonelection of advanced math courses take on even broader significance. Women represent about 47% of the U.S. labor force and account for 42% of those engaged in professional occupations, but they account for only 12% of the scientific or technical careers.*

If one assumes that the nonelection of advanced math courses greatly reduces the possibility of entering certain scientific or technical programs of study at the undergraduate and graduate level, then one may also assume that underrepresentation of women in advanced math courses is related to the insufficient representation of women in scientific or technical careers. Simply stated, career options for women may be severely limited by the decision not to pursue the study of mathematics beyond that which is required to earn a high school diploma.

The statistics cited above suggest the scope and nature of the problem; they do not, however, account for the reasons that precipitated it. It is not known if the problem arises because the field of mathematics has become sex-stereotyped and such stereotyped values are somehow transmitted to women during their early interactions with school and other cultural institutions. The socialization process experienced by most

* National Center for Educational Statistics (1973 data) and Bureau of Labor Statistics (1977 data).

women may convey the message that careers requiring an extensive background in mathematics are "masculine domains." The nature of such sex bias, the way in which it is transmitted, and the manner in which it impinges on women's decisions to take advanced courses in mathematics is the primary focus of this study.

Within the American cultural ethos there are numerous possible sources of sex bias which, singly or in combination, may account for this phenomenon. Schools, parental interactions, and peer relationships all possess the inherent capability for transmitting sex bias. Since all of these sources of influence are interactive and may operate within a framework of shared values and goals, the likelihood that sexist values are transmitted and reinforced is greatly augmented.

If schools are considered as primary socializing institutions within which key cultural values are transmitted to students, then they must be construed as prime candidates for the transmission of sexist beliefs. Within the school are several possible conduits for the transmission of sex stereotypic values in relation to mathematics and careers, some of which are discussed briefly below:

- Teachers, both in the area of mathematics and other subjects, may transmit sex bias in their instructional behavior. Whether through explicit statements or through implicit behavioral cues, whether consciously or unconsciously, teachers may instruct male and female students differently. In the conscious and explicit mode, for example, teachers may use different criteria for assessing the progress of men and women students; or they may make statements which convey the belief that "mathematics is not a suitable subject for women." In the unconscious and implicit mode, teachers may respond differently to questions posed by male students than they do to questions raised by female students; they may be more willing to spend time "rapping" after class with men students than with women, or they may advise men and women differently on whether or not to take more advanced math courses.
- Counselors can be critical influences in students' selection of courses. Thus they must be considered as potential sources for the transmission of sex values in relation to mathematics and careers. Male and female guidance counselors may provide advice on the basis of the sex of the students with whom they are interacting. It is possible, for example, that counselors perceive mathematics and careers related to mathematics in a sex-stereotypic manner and that they advise men and women students on the selection of advanced math courses accordingly.

- School administrators, while they do not as a rule interact with students on a frequent basis, may hold sexist attitudes regarding mathematics that they transmit in shaping school-related instructional policies. Biases could be reflected in career education programs that expose women to a wide range of non-math-related careers while exposing men to math-related careers. Professional women invited to speak on career days may or may not be from math-related occupations. To the extent that administrative sanction is required for extracurricular activities within the school, administrators may discourage activities intended to remediate sex bias, such as clubs for women students or consciousness-raising groups. They may or may not invite women professionals to address school assemblies or to speak with students during a school activity, such as career day. Finally, administrators may act in implicitly sexist ways by hiring only male math teachers or assigning male teachers or counselors to more responsible positions.

Even this brief description of potential sources of sex bias in the school setting suggests that many of women's decisions regarding the pursuit of advanced math courses may be explained by school-related factors. Schools, however, while they may "teach" or reinforce sexist attitudes in relation to mathematics or careers, are not the only potential source of sex bias. The relationship of high school students to their parents can also be considered as a likely influence on decisions relating to course selection and career options. Parents may, for example, serve implicitly as sex-role models and as the transmitters of explicit values which indicate to daughters that they should or should not pursue various courses of study. Such related factors as the occupations of the father and mother and parental socioeconomic status most likely convey strong messages about "acceptable" courses and careers.

Sex bias transmitted by school and parents may be reinforced or counteracted by peer influence. If, for example, in a given school, the percentage of girls enrolled in advanced math courses is fairly high, women students facing the critical decision as to whether or not to take advanced courses may feel comfortable in electing to take them. Conversely, in a school with low female enrollment in such courses, or in cases in which friends elect not to take such courses, women students approaching the decision point may elect not to undertake additional work in mathematics. Peer groups can exert more subtle influences as well.

It is possible, for example, that the interaction of women students with each other is characterized by the same sex-role behavior as that promulgated by the school and parents. The interaction of men and women students may further serve to reinforce sexist values relating to the study of mathematics and selection of careers.

In addition to the possible sources of sex bias discussed above, the ethos of American culture must also be considered as a potential source of sexist values that have a significant impact on women's decisions in relation to advanced mathematics. The transmission of sexist values may have a cumulative effect on women which, when considered in the context of other influences converging upon them, may further discourage them from electing to pursue courses in mathematics beyond those required. The "woman-as-homemaker" image insidiously advocated by television for example, cannot help but be etched on the consciousness of young women belonging to a generation of television watchers. The housewife image with which the television medium saturates the American viewer may be reinforced by the traditional attitude regarding women as objects to be cherished and protected, not as individuals who question and probe.

The problem of women's underrepresentation in advanced math courses and scientific or technical careers, while it may be simply stated, probably has multiple antecedents, all of which interact. It is the intent of this study to define and describe the several influences impinging on women's decisions regarding whether or not to pursue advanced courses in mathematics, to analyze the interrelationships among these forces, and to identify ways in which each of these forces contributes to a decision concerning the further study of mathematics.

Review of Related Research

The most serious problem facing those concerned with equity in math education is ensuring that women continue their study of mathematics (Fennema, 1976). A number of recent studies have attempted to identify factors influencing the decision of women to continue their math education. The results of most of these studies, which are primarily cross-sectional, are inconclusive because of failure to control for relevant

variables or because of inadequate research design or analysis. In a review of 36 studies on the sex-related differences in math education, Fennema (1974) argues that those studies should have controlled for two confounding effects. First, more lower-ability men than women students drop out of high school, resulting in a more homogeneous sample of men. Second, the women students who do elect mathematics courses appear brighter than those who do not, thus creating a lower-ability sample of women students not taking mathematics.

Clearly, a carefully designed, systematic study of women's participation in mathematics at the secondary level is needed to determine why fewer women than men enroll in mathematics courses. Factors that appear to be relevant to women's avoidance of mathematics include:

- Sexual stereotyping of mathematics as a male domain.
- Perceived utility of mathematics courses.
- Peer influence.
- Parental influence.
- Difference in math aptitude and achievement of men and women.
- Math-related school programs and counselor advice.
- Sex-related attitudes of math teachers and treatment of male and female students in classrooms.

Sexual Stereotyping of Mathematics as a Male Domain

In the high school years, both men and women were found more likely to perceive mathematics as a male domain (Ernest, 1976; Fennema and Sherman, 1977b). There appears to be no significant difference between the sexes in terms of liking the subject (Ernest, 1976; Aiken, 1976; Fox, 1974b; 1975a).

Women's low mathematical self-concept possibly may be a result of the sexual stereotyping of mathematics as a male domain. Women tend to underestimate their intellectual abilities (Maccoby and Jacklin, 1974) and feel inadequate in many kinds of problem-solving activities (Kagan, 1964). This lack of self-confidence results often in mathematical anxiety (Ernest, 1976; Fennema and Sherman, 1977b; Donady and Tobias, 1977; Tobias, 1976; Levine, 1976). Even though women's low math self-concepts

tend to decrease with age, Fennema (1974) found low self-concepts among women who were achieving better than men.

Perceived Utility of Mathematics Courses

A woman's perception of the usefulness of mathematics to her future activities is likely to affect her participation in mathematics courses. Much of the literature suggests that women in high school feel that their roles as wife and mother preclude involvement in a traditionally male-dominated occupation. Hawley (1971) found marriage to be one of the primary goals for most high school women. Astin (1974a) concluded that if a woman anticipated a conflict between her roles as homemaker and career woman she would give up her career. Fennema and Sherman (1977b) hypothesized that women do not see mathematics as an appropriate activity and do not recognize the usefulness of math in their career plans. In a study of 881 men and 878 women in secondary schools, Hilton and Berglund (1974) found that men perceived mathematics as more likely to be helpful in earning a living than did women. However, the Fennema and Sherman study did not find as great a difference between men's and women's beliefs as was found in the Hilton-Berglund study. It is suggested by Fennema and Sherman that this discrepancy in findings may indicate that the beliefs of women are becoming more similar to men in this respect. Fox (1976) attributes the difference in the perceived usefulness of mathematics to women's lack of orientation to careers other than home-making, interests in fields other than mathematics and science, and unawareness of the relevance of mathematics and science to technical professions.

Peer Influence

Numerous studies show that peers exert a strong influence on adolescent attitudes and behavior (Coleman, 1961; Cusick, 1973; Rigsby and McDill, 1972; Hauser, Sewell, and Alwyn, 1976). Little research, however, has specifically examined the influence of peers on the decision of women to study mathematics. The few studies that do exist point to students' stereotypes about appropriate sex-linked behavior as an important agent

of peer pressure. Matthews and Tiedeman (1964) reported that a decline in career commitment by women of high school age was related to perceptions of male classmates, and disapproval of the use of female intelligence. Many researchers have reported that women are reluctant to continue with mathematics due to fear of social recrimination (Casserly, 1975; Fennema and Sherman, 1977b; Fox, 1976; Levine, 1976; Solano, 1976). In an effort to encourage higher enrollment of women in mathematics classes, all-women math classes have been introduced as an intervention strategy with varying degrees of success (Fox, 1974a; Hawley, 1971). A more acceptable alternative, early tracking of women in academic programs, has been recommended (Casserly, 1975; Fox, 1976; Haven, 1971; Sells, 1978a).

Parental Influence

Students may be influenced also by parents who hold sex-stereotyped views of women in mathematics. Fennema and Sherman (1976, 1977a) showed that student reports of parental perceptions of the child as a learner of mathematics reflected sex differences. Researchers argue that parental encouragement of women to enroll in advanced mathematics is a crucial but often absent influence (Aiken, 1972a; Haven, 1971; Fennema and Sherman, 1977a; Poffenberger and Norton, 1956). Block (1973) found that parents stress interpersonal relations and affection with their daughters whereas they emphasize achievement, competition, and control of feelings with their sons. Fathers were found to help more in mathematics homework than did mothers in the higher grades (Ernest, 1976). Levine (1976) reported that mothers accepted low mathematics achievement from their daughters because of their own lack of ability in mathematics. The mothers' low mathematics self-concept may explain their reluctance to help with mathematics homework. Parents report buying more scientific games and toys for sons (Hilton and Berglund, 1974; Maccoby and Jacklin, 1974) and offering more rewards and reinforcements to their sons to learn mathematics than to their daughters (Astin, 1974a).

The literature also suggests that parents hold lower educational and vocational aspirations for their daughters than for their sons.

Fox (1975b) found that more men than women perceived their parents as favoring acceleration in mathematics. Casserly (1975) found that parents do not expect their daughters to achieve as much as their sons. It has also been found that daughters who identify with their fathers, or who have working mothers, tend to enroll in higher level mathematics courses (Astin, 1974b; Astin, Harway, and McNamara, 1976).

Differences in Math Aptitude and Achievement of Men and Women

It has been generally accepted that there are sex differences on mathematical achievement tests (Aiken, 1976; Astin, 1974b; Fox, 1975a; Maccoby and Jacklin, 1974). Fennema and Sherman (1977a) have found minimal sex-related differences in mathematical achievement in grades six through nine, and in half of the high schools studied men achieved at higher levels than women. Studies have also indicated trends for men to perform better on higher level cognitive tasks (Fennema and Sherman, 1977a). Stafford (1972) suggests a hypothesis that a sex-linked recessive characteristic is the cause for this difference.

An area of intellectual development most often related to mathematics learning is spatial visualization. Women have been reported to perform lower than men on spatial visualization tests (Fennema, 1974; Maccoby and Jacklin, 1974). Sherman and Fennema (1977) have found that men are not invariably superior in mathematics achievement and spatial visualization. They suggest the influence of sociocultural factors to be highly important concomitants of sex-related differences.

The inconclusive and inconsistent findings for sex differences in mathematical achievement and aptitude may be due to the failure to control for differential course taking (Fennema and Sherman, 1976, 1977a, 1977b). It is hypothesized that the best predictors of success in mathematics are previous mathematical learning and intelligence tests. Because the number of women who have equal capability with men for learning high school mathematics is larger than the number of women who elect to study mathematics, the studies reported in the past are reflecting this difference in numbers. The results of the two national studies that claim

higher achievement for men, Project TALENT (Flanagan, 1976) and the National Assessment of Educational Progress (Mullis, 1975), merit the same criticism because they failed to control for educational or mathematical background. Fox (1975b) and Astin (1974b), however, have found large sex differences in favor of men among gifted students as early as grade seven.

Math-Related School Programs and Counselor Advice

Few studies can be located that focus to any extent on the overall setting in which secondary school instruction in mathematics takes place. Little reference is found in the literature to such potentially significant factors as administrative support for increasing women's enrollment in mathematics, organizing school programs to facilitate increased enrollment by women in mathematics courses, or provisions of informational materials to increase awareness of the potential value of mathematics courses.

Occasional references to the value of role models in stimulating interest of women in the mathematics field appear in the literature. In a review of National Science Foundation projects, Lantz, West, and Elliott (1976) report that role models were the most significant factor affecting women's enrollment in mathematics in some of the projects studied. Prediger, McClure, and Noeth (1976) found role models in mathematics to be more successful than those in other informational careers in science and technology.

Two highly visible role models in the school setting are the teacher and the counselor. The influence of the teacher will be discussed in the next section. Fox (1976) reported that counselors are seen as the least potent influence upon the child. Still, women are more likely to seek advice from counselors than men (Harway et al., 1976), particularly regarding advanced mathematics courses (Haven, 1971).

A few counselors have actually admitted discouraging women students from taking advanced mathematics courses (Casserly, 1975; Luchins, 1976). This discouragement or lack of encouragement may be a reflection of the

counselor's biases. Schlossberg and Pietrofesa (1973) found that one of the major determinants of a counselor's advice is the counselor's opinion of what behavior is appropriate for women in society. Thomas and Stewart (1971) showed that both men and women counselors rated traditionally feminine career goals of women students as more appropriate than traditionally masculine career goals. Schlossberg and Pietrofesa (1973) observed interviews of counselors and women students concerning the decision to major in engineering and discovered that more than three-fourths of the statements made by the counselors of both sexes were biased against the choice of the engineering major.

The counselors' stereotypical attitudes are reported to be decreasing during the present decade (Englehard, Jones, and Stiggins, 1976). MacDonald (1978) and Ernest (1976) have recommended that counselors increase mathematics awareness by beginning career education programs early, upgrading existing career education programs, and counseling students to continue their mathematics training.

Sex-Related Attitudes of Math Teachers and Treatment of Male and Female Students in Classrooms

The literature on teacher expectations for pupil behavior suggests that differential expectations for men and women students may be a factor in the low enrollment of women in mathematics courses. Many of the more recent studies on teacher attitudes toward mathematics involved prospective teachers for the elementary level. Ernest (1976) reported that 41% of the teachers he studied felt men did better in mathematics, while none felt women did better. Teachers also appear to have more negative perceptions of mathematically gifted women (Solano, 1976) and in fact can be hostile (Fox, 1974a, 1975a).

Although teacher/student interaction is believed to be an important factor in the decision of women to enroll in mathematics courses, few classroom interaction studies focusing on differential treatment and response by sex can be found. Sears and Feldman (1966) found that in the 76 studies reporting classroom observation in the Handbook of Research on Teaching (Gage, 1963), not one indicated to whom--man or woman--the

teacher behavior was directed. In the Second Handbook of Research on Teaching (Travers, 1973) we noted this same missing treatment in the reported observational studies. These authors did recognize, however, the need for future research studies to allow for individual differences. Aiken (1972) reported on more recent investigations pertaining to the importance of verbal factors in the learning of mathematics. Much of the research conducted to date on teacher/student interaction has involved samples at the elementary level (Meyer and Thompson, 1963; Spaulding, 1963; Fey, 1969). In one of the few classroom interaction studies at the secondary level, Bean (1976) showed that teachers initiated more contacts with men students than with women students, although no corresponding sex differences were found in the number of student contacts with the teacher. Other researchers have supported these findings (Good, Sikes, and Brophy, 1973). A study by Dweck and Reppucci (1973) suggests that mathematics teachers provide different feedback to men than to women when the students give a wrong answer. Men are told to try harder; women are praised for trying at all. Future research is needed to determine specifically whether secondary school teachers tend to expect higher achievement in mathematics by men than women and whether teachers differentiate between the sexes in rewarding mathematics achievement.

The studies reported above contribute to the findings on how and why women make decisions to enroll in elective mathematics classes by providing data regarding students' perceptions of the factors affecting their decisions about what courses to take.

The next section of this report discusses the design and objectives of this study, and the major issues addressed by the analysis.

III STUDY DESIGN AND PROCEDURES

Based upon the findings of prior research many hypotheses can be generated regarding why women do or do not continue to take advanced mathematics classes. However, there is little agreement among researchers and few replication studies have been conducted. Our own hypothesis is that several influences come to bear upon students. We think these include: (1) instructional factors (mathematics teachers' attitudes and treatment of men and women students, (2) school factors (counselors, peers, career education programs), and (3) personal factors (aptitude, ability, career plans, parent expectations). Which of these factors exerts the most influence upon women's decisions will be examined in this study. Further we will consider how our findings relate to the findings of other researchers.

The factors we have defined were studied in four urban and seven suburban high schools in the San Francisco Bay Area. Schools with high, medium, and low female enrollment in advanced math classes were represented.* In each school, classes of general math, algebra I, geometry, algebra II, trigonometry, and/or calculus were studied. For the purposes of analysis, math classes were divided into three types:

- Type I: General Math
- Type II: Algebra I, Geometry
- Type III: Algebra II, Trigonometry, Calculus.

In the spring of 1978, students in the sample of math classes were asked whether they had enrolled in a math class for the summer school or for Fall 1978. The decision whether they were or were not taking another

* In schools with high enrollment 48% or more of the students enrolled in advanced math classes were women; in schools with low enrollment 37% or less of the students enrolled in advanced math classes were women.

class in mathematics was obtained through a questionnaire administered to all students in the sample classes. The decision and the reason for making the decision were then contrasted for women and men in urban and suburban schools.

Study Variables

Three categories of independent variables were studied:

- The effect of mathematics teachers on students' attitudes
- The effect of the global school environment
- The student's personal background.

To study the effect of the teacher on students' attitudes toward mathematics and their decisions to take another class, systematic observations of classroom instructional processes were conducted. The SRI Secondary Observation Instrument enabled us to identify when a male or a female student was speaking or being spoken to. We were able to contrast for men and women the number and kinds of questions asked, support or feedback provided by the teacher, frequency of interaction, amount of personal assistance received, emotional affect registered, and any math career-related statements made.*

The teacher's effect on students was also studied through a Student Rating Scale of Instructors. This rating scale provides an estimate of the student's perception of the teacher's professionalism and fairness. The students also indicated how much personalized attention they received and how much they enjoyed the instruction.

Teachers' perceptions of men and women students were studied by data obtained from a teacher's questionnaire.

The effect of the more global school environment (i.e., peers, counselors, math programs, and career education) was documented in counselor questionnaires and interviews with administrators.

*Appendix A includes samples of all instruments; Appendix B lists classroom process variables observed.

The students' personal backgrounds were also used as independent variables. The effects of the parents' education, occupation, and expectations for the student to enroll in mathematics, were examined. The students' math aptitude, interest in mathematics, and awareness of math-related careers were documented. All of this information was obtained from a student questionnaire.

The primary dependent variable of the study was the student's decision to enroll or not to enroll in another math class. Other dependent variables were scores on a criterion test (one for each level in mathematics), math aptitude, and awareness of the utility of mathematics.

Comparisons of independent and dependent variables were made between schools with high enrollment and schools with low enrollment of women in math classes.

Objectives and Hypotheses

The stated study objectives are (1) to identify major factors influencing women students' decisions to enroll or not to enroll in advanced math courses and (2) to identify math programs or career education programs that are related to high enrollment of women in math courses.

Examination of the following hypotheses* permitted us to compare our findings with findings from past research efforts. In contrast with other studies, the design of this study provides information regarding the factors influencing the decisions of women to enroll in advanced math classes in urban and suburban schools with both high and low enrollments of women in these classes.

- (1) Factors (parents, peers, teachers, counselors, programs, potential careers or college plans) identified by students as most influential in their decision to enroll or not to enroll in an elective math class will be identified and they will vary by school, location, and by high and low involvement of women in advanced math classes.

* In this pilot study, these hypotheses were used as preliminary guides for the research. Classical statistical hypotheses testing is not always useful in pilot research, so more informal methods were used to examine the study questions.

- (2) A positive relationship will be found between math aptitude and ability and decisions to continue in advanced math classes; men's and women's math aptitude and ability will be similar for students in advanced math classes.
- (3) Particular combinations of classroom processes will be related to high enrollment of women in math classes.
- (4) Differential treatment of men and women students will be observed in math classrooms and this difference will be related to enrollment in advanced math classes.
- (5) Schools in which women students are exposed to math-related programs or career education programs will have a higher enrollment of women in math classes than will schools without such interventions.

Sampling Plan

To select schools for the sample, we conducted telephone interviews of all high schools in San Francisco/Oakland areas in December 1977-January 1978. The interviewer asked:

- What courses in mathematics are offered at the school? (algebra, geometry, algebra II, calculus, trigonometry, etc.)
- How many students are enrolled in each of the classes?
- How many of the students in each class are women?
- Is there a career education program emphasizing mathematics or other math-related programs operating in the school?

From these interview data, schools were ranked according to the percentage of women in elective math classes. Schools selected for the study offered advanced math classes (algebra II, trigonometry, and calculus). From the rank ordering of schools with such classes, the two urban schools and the two suburban schools with the highest enrollment and the two with the lowest enrollment of women in advanced math classes were selected for the sample. Figure 1 illustrates the design at this stage.

Originally, the SRI Women and Math study was to be limited to eight high schools. During informal conversations with the superintendent of another local high school district, it was brought to our attention that the issue of underrepresentation of women in high school math courses was currently a concern in that district. An interest in the study was expressed, and the district requested that their three high schools be

		Geographical Descriptor	
		Urban	Suburban
Female Enrollment in Advanced Math Courses	High	2	2
	Low	2	2

N=8 schools

Figure 1 SAMPLING DESIGN--FIRST-STAGE 4-CELL MATRIX

permitted to participate. The costs of their participation in the study were underwritten by the district. The three additional suburban high schools were classified as medium enrollment schools because the percentage of women in advanced math courses was close to the mean for all Bay Area schools (40%).

The final study sample is shown in Table 1. The percentage of women enrolled in advanced math classes is compared to the percentage of all students enrolled in advanced math classes.

Within each of the 11 schools, 10 classes were chosen for study. Where possible, two general math, two algebra, two geometry, and four advanced math classes (e.g., algebra II, trigonometry, calculus, computer science) were selected. See Table 2 for the distribution of final sample, by school and subject.

Each classroom in the study was observed for three class periods. All students in the classes were administered tests and questionnaires. Testings in the classroom required two periods. All data were collected by SRI staff or trained field hires. Because geometry is the pivotal point for taking more mathematics than is required by the California university system, we elected to focus our analysis primarily on the transition from geometry to advanced elective classes. We wanted to investigate why some students continued math studies at this critical point, while others did not. Accordingly, we limited student interviews to geometry classes.

In each geometry class, four students were selected for interviews. One male and one female student were randomly selected from two pools of students: male students and female students enrolled in an advanced math class for summer or fall of 1978, and male and female students not enrolled in advanced math classes for summer or fall of 1978.

Since few schools in each area had high and low female enrollment in math classes, and since the high schools had few math classes, there was no possibility of random assignment of schools or classes to cells in our study. Therefore, the findings of the study can only be generalized to other cities with populations similar to the San Francisco/Oakland urban and suburban areas.

Table 1
FINAL STUDY SAMPLE

<u>School</u>	<u>Total Enrollment</u>	<u>Total Number Math Classes Offered</u>	<u>% Students Enrolled in Advanced Math Classes</u>	<u>% Women Enrolled in Advanced Math Classes</u>	<u>Enrollment Classification</u>
1 Urban	2600	55	17%	57%	High
2 Urban	1676	27	25	63	High
3 Urban	2200	42	11	37	Low
4 Urban	2200	54	10	35	Low
5 Suburban	1665	55	9	48	High
6 Suburban	1558	31	10	48	High
7 Suburban	2345	60	12	32	Low
8 Suburban	2400	72	7	35	Low
9 Suburban	1320	36	13	36	Medium
10 Suburban	1680	39	8	39	Medium
11 Suburban	1260	33	14	41	Medium

Table 2

DISTRIBUTION OF TEACHERS AND CLASSES BY SCHOOL AND SUBJECT

School	General Math and Prealgebra	Algebra I	Geometry	Algebra II and Trigonometry	Precalculus and Calculus	Computer Science	Probability and Statistics	Total Number of Classes	Number of Teachers
ban	2	2	2	1	1		1	9	7
ban	2	2	2	1	1			8	8
ban	2	2	2	2	1			9	8
ban	2	2	2	2		1	1	10	7
burban	2	1	2	2	1	1		9	7
burban	2	2	2	1	2			9	7
burban	2	2	2	2	1			9	8
burban	2	2	2	1	3			10	9
burban			2	2	2			6	5
burban			2	2	2			6	6
burban	—	—	2	2	2	—	—	6	4
Totals	16	15	22	18	16	2	2	91*	76*

5 teachers were observed in more than one math class.

Instruments

To collect data that would allow an examination of the many factors that might influence women's decisions to enroll in advanced math classes, a variety of instrumentation was used. These included: survey reports, questionnaires, interview guides, tests, rating scales, and observation instruments (see Appendix A for samples of all instruments).

A telephone survey report was used to select the sample of schools with high and low enrollment of women in advanced math classes and to identify schools with high and low intensity math-related career information programs.

Information on students was collected by four instruments: a student questionnaire, a student interview guide, a space relationships test to assess math aptitude, and a mathematics criterion-referenced achievement test. The student questionnaire and interview protocols were used to assess students' decisions to enroll in math classes. Teacher and classroom data were obtained from three sources: a teacher questionnaire, a Student Rating Scale of Instructors, and the SRI Secondary Observation system. Finally, an interview guide for high school administrators and a counselor questionnaire were used to obtain more global information about the school environment.

The testing instruments and the Student Rating Scale of Instructors have been used in previous studies in secondary schools and required no adaptation for this study. The SRI Classroom Observation Instrument required slight modifications. The survey report, the questionnaires, and the interview protocols were developed and pilot tested within this study.

Teacher Questionnaire

The teacher questionnaire was designed to collect data around three foci: teachers' attitudes regarding the subject of mathematics (i.e., do teachers perceive mathematics as a "male" subject?); teachers' attitudes regarding their own teaching (i.e., do teachers believe that their instructional behavior is sex-biased?); and teachers' perceptions of the problem of female underrepresentation in advanced mathematics

(i.e., do teachers perceive that a problem exists?). This questionnaire had 26 items and took no longer than 20 minutes to complete.

The teacher questionnaire was field-tested with all the math teachers in one high school. Questionnaires were delivered to the teachers, brief explanations of the study and its objectives were given, and the questionnaires were left with the teachers for completion within a few days. The teachers were asked to work independently. They were asked to write comments, criticisms, and recommendations about the questionnaire. Questionnaires were picked up within one week of administration, and discussions were held with the group of respondents to elicit reactions to the instruments.

Minor changes in the formatting of items were made following this pretest, and the final version of the questionnaire was prepared for use in the study.

Counselor Questionnaire

Counselors are another possible source of school-related sex bias. To the extent that counselors advise students regarding what courses to pursue, counselors may play a critical role in women's decisions about the election of advanced math courses. Counselors use different criteria for advising men and women students, if they perceive mathematics as essentially a "male subject," or if they provide students with career advice and tend to sex stereotype certain math-related careers, counselors may account for a large number of the factors that may be considered by women students when deciding about whether or not to pursue advanced math courses.

A questionnaire focusing on these factors was developed by SRI staff and pilot tested in two high schools. The questionnaire was short, taking no more than 20 minutes for 23 items. Questionnaires were delivered to the counselors, brief explanations of the study and its objectives were given, and the questionnaires were left with the respondents for completion within a few days. The counselors were asked to work independently and to write comments, criticisms, and recommendations about the questionnaire. Questionnaires were picked up within a week of administration,

and discussions were held with the groups from both schools to elicit reactions to the instruments.

Changes in the formatting of items were made following this pilot test, and the final version of the questionnaire was prepared for use in the study.

Student Questionnaire

It is important to discover how students feel about mathematics and whether the students perceive mathematics or mathematics-related careers as being sex stereotyped. Counselors and/or teachers may or may not perceive themselves as holding or transmitting sexist attitudes in relation to mathematics. However, it is important to discover whether students perceive counselors and teachers as holding such attitudes and to what extent this perception influences the decisions students make. Further, whether parents' or peers' opinions affect the way students feel about mathematics is important to know. The intent of the student questionnaire was to examine those specific points.

The student questionnaire was developed at SRI, and a pilot test involving five students picked at random in one high school was conducted. Following revisions resulting from the pilot test, a formal pretest/post-test was conducted in a second high school. Students were volunteers who responded to a request announced over the school speaker system. The sample consisted of seven freshmen, four sophomores, and one senior. Five of the students were men (including a pair of identical twins) and seven students were women (including two sisters). Half the students were black (all but one of the women) and half white (all the men, and one of the women).

For the pretest administration, the students were brought together after school hours and the project and task were explained to them. They were asked to fill in the questionnaire, and told that there were no right or wrong answers. Further, they were told not to ask for explanations about any questions; if they did not understand the wording or the format they were to leave it for discussion later. It was pointed out to them that we were looking for problems in wording and format.

The questionnaire took about 20 minutes to complete, and 30 minutes were taken up later in discussion. The students were very interested in the mechanism of the pretest and the fact that they were acting as consultants. Their input was very constructive.

Three weeks later the same 12 students were assembled and asked to complete the identical questionnaire. They were informed that their previous input had already indicated necessary changes in items on the questionnaire. The item verification process was explained and it was emphasized that this was not to test their memories or honesty, but simply to see what questions received the same answers consistently. All questions and recommendations were received at the conclusion of the posttest. Students were paid \$6 for participating in the task.

Overall, responses from pretest to posttest were found to be sufficiently consistent. Six of the 24 items were changed slightly after the posttest, primarily to clarify the questions through a change of format.

Student Interviews

The chief advantage of utilizing questionnaires is that they are easy to administer and they provide data that can be analyzed reasonably quickly. The primary disadvantage of questionnaires is that their format precludes the possibility of in-depth probing. To overcome this inherent drawback of questionnaires, student interviews were conducted with a stratified subsample of students, both men and women. The interview subsample was stratified by sex and by students' decisions to pursue or not to pursue additional math courses. The intent of the interviews was to collect comprehensive data regarding why students decided to pursue or not to pursue advanced courses in mathematics. Within the context of the interview, data were collected regarding students' perceptions of those factors that influenced their decisions.

The interview protocols call for probing into areas such as how the student likes the school, how they like math classes, and how they feel about what they're learning in math classes. If they did not like mathematics we asked when they started to feel that way. Most of the probes

were based on the answers students had given on the questionnaire. Although the interviews were highly structured, the protocols permitted interviewers ample opportunity to probe for responses in areas of interest to this study. For the most part, the interview protocol was close-ended, permitting the interviews to be conducted during no more than 30 minutes.

Student Rating Scale of Instructors

Instructional processes were assessed through the Student Rating Scale of Instructors. This rating scale allows us to examine students' subjective viewpoints of certain aspects of classroom processes. This rating scale was developed in 1973 by the staff of Sequoia High School District in California and has been used in secondary classrooms in that district. The rating scale allows the student to select on a five-point scale a rating number that, in the student's opinion, best describes an instructor in areas such as clearness of course objectives, clearness of assignments, fairness in grading, classroom control in discipline, preparation for the class, communication, friendliness, course content, helpfulness, participation, and encouragement of independent ideas. Four scales are obtained from the Student Rating Scale of Instructors. Each scale can be used in analysis to describe the students' perception of the instructors. See Appendix A for items on the Student Rating Scale.

SRI Secondary Observation Instrument

In order to examine classroom processes that might enter into the decisionmaking process, the SRI Secondary Observation Instrument (SOI) was used. This instrument was based on an observation system developed at SRI for use in secondary reading classrooms. Modifications were made that would allow observers to record events that occur in senior high math classes and to identify whether a teacher was interacting with a male or female student.

The SOI contains three sections. The first section, Identification Information, identifies the schools, teachers, classes, the number of adults, and male and female students present in the classroom.

The second section is the Classroom Snapshot. The Snapshot is a matrix that yields data about the activities of each adult and student in the classroom, the size of the group, and the materials being used. From this record, information is obtained on how the teacher spends his or her time and with whom, how the aides spend their time and with whom, and how often the students operate independently and in what activities. This record is made five times during a class period. Three days of observation produced 15 snapshots for each class observed.

The third section, the Five Minute Interaction (FMI), is used to record the teacher's verbal interactions or nonverbal behaviors. It consists of a series of frames in which each behavior/interaction is recorded in the four categories provided: Who, To Whom, What, and How. Consecutive frames can record 72 continuous interactions during a five-minute period. Five of these five-minute interactions are recorded during one class period. Over the three days of observation, this provided 15 five-minute interactions and an approximate 900+ interaction frames, for each class.

Modifications were made to the SOI in order to capture variables that appeared crucial to a study of math classes. Some of those variables are:

- Use of clarifying questions to be certain that the students understand the math instruction.
- Encouragement/support to solve a difficult problem.
- Reference to future utility of math instruction in students' career or academic plans.
- Review and correction of previously assigned work.
- Use of some type of visual instruction such as a chalkboard or overhead projector.

It was also necessary to modify the instrument to capture whether interactions between teachers and students showed indications of sex biases. Therefore, codes were developed that allowed the observer to record the sex of individual students. Adapting the coding system in this way allowed us to answer questions such as:

- When the teacher asks questions of the entire class, who volunteers answers more often--male or female students?
- When the teacher calls on a specific student, is it more often a male or female student?

We can also assess what kind of feedback praise or criticism male and female students receive. See Appendix A for the Observation Instrument. Appendix B contains a list of snapshot and FMI variables.

Administrator Interview Guide

An administrator interview guide developed to gather information on categorical aid programs, per pupil expenditures, and special career education programs. Several questions were asked regarding the importance placed by the school on math education and increasing students'--particularly women's--interest in mathematics. The interviews were well focused and took approximately 20 minutes.

Mathematics Criterion Tests

It is quite possible that math achievement and/or math ability, real or perceived, will have a strong impact on whether a student enrolls in advanced math courses. In order to examine this area, mathematics criterion tests were administered to all students participating in the study.

Rather than developing mathematics criterion tests for all levels of classes involved in this study, SRI used an established battery of tests recommended by math department chairpersons at several local schools: the Cooperative Mathematics Tests developed by Educational Testing Service and published by Addison-Wesley. Separate tests were given at the following levels: general math (arithmetic), first-year algebra, geometry, second-year algebra, trigonometry, analytical geometry, and calculus.

Space Relations Test

To examine math aptitude, the Space Relations Subtest was used. This subtest (from the Differential Aptitude Tests, developed by George K. Bennett, Harold G. Seashore, and Alexander G. Wesman), published by The Psychological Corporation, has been described by past reviewers as the best available instrument of its kind. Significantly for this study, separate norms are available for males and females.

Design of Data Analysis

To examine the study hypotheses, three levels of analysis were of interest: the individual student, the classroom setting, and school programs. The purpose of the individual-level analysis was to identify factors related to the decision of women to continue in advanced elective math classes. Therefore, we compared those women continuing from geometry into advanced mathematics with those not continuing. From the 11 schools, 22 classes were sampled for this analysis. This allowed 2 geometry classes per school. In schools that had more than two geometry classes, the head of the math department selected the two classes from those who volunteered.

One postulate to be examined was that the decisions to continue might vary by school setting. Accordingly, five types of aggregation were considered: pooled across schools, low involvement schools, high involvement schools, urban schools, and suburban schools.

A discriminant analysis using women continuing in advanced math classes and women not continuing was conducted to identify factors related to the decision to continue. If the discriminant function was successful in correctly classifying the students into their appropriate groups (continue/not continue), further detail was gathered by a one way analysis of variance on the variables in the function. These discriminant function analysis results are presented by describing the variables that predicted continuance in mathematics. This analysis was repeated for men, and the results compared to determine whether the men continued or stopped for the same reasons as the women. In this manner, we were able to identify factors related to women continuing in mathematics, and to compare these factors for different school aggregates; that is, to determine whether these factors were the same for students from urban and nonurban schools, for students from schools with different levels of involvement of women in advanced mathematics, and for the total sample of women (pooled across schools).

At the classroom level, we focused on describing the relationships between classroom process and teacher questionnaire variables and the

continuation rate for women in the different geometry classes. Nine categories of classrooms were defined based on the percentage of women continuing from geometry into advanced math classes, ranging from 45% to 100%. Tables were generated to describe the relationships between the classroom continuation rates and observation variables, and teacher questionnaire variables. We looked for trends among these variables across the different types of classes. For example, were certain teacher behaviors more prominent in classes with more women continuing than in those with lower continuation rates? Frequency and types of classroom interactions with men and women were compared.

In summary, the combination of an intensive individual-level analysis and a descriptive analysis at the classroom level allowed us to uncover factors related to women taking advanced math courses, and to uncover more general classroom and teacher characteristics related to this criterion. School career education, counseling, and math programs were described and compared to ascertain whether women students were being encouraged more in some schools than others to enroll in advanced math classes.

IV DATA COLLECTION PROCEDURES AND ACTIVITIES

General Policies and Practices in Field Data Gathering

The primary concerns were to collect data that describe: (1) school policies, programs, and environments; (2) student, teacher, and administrator perceptions of the factors influencing students' decisions to take elective math courses; and (3) teacher behaviors and classroom settings. A major goal of field activities was consistency, both within and across sites, in the procedures followed and in the degree of validity of collected data.

The data gathering activities were conducted through a series of telephone contacts and site visits with each sample district. Instrumentation included telephone interview reports, student achievement and aptitude tests, questionnaires for teachers, counselors, and students, interviews with school administrators and students, and the Secondary Observation Instrument. The schedule of contacts and site visits is listed in Table 3.

All visits were coordinated with math department chairpersons, who advised SRI of desirable times for visits and contacted teachers in advance of those visits.

Because of the diversity of data sought, every effort was made to ensure that procedural guidelines were rigorous and complete. Prior to visiting the sites, each member of the data collection team received training for the specific data collection procedures scheduled for the visit. Pre-visit orientations emphasized the importance of establishing cordial working relationships with administrators, teachers, and other school staff, and making sure that everyone understood that SRI observers were working in the role of researcher, not that of program evaluator.

Table 3
CONTACTS WITH SAMPLE SCHOOLS

<u>Contact</u>	<u>Major Purpose</u>	<u>Date (1978)</u>
1	Telephone survey to construct sampling frame	January
2	Obtain approval of school administrator for participation in study	Feb-March
3	Recruit teachers for sample	March-April
4	Prepare for spring data collection	April
5	Collect classroom observation data	April-May
6	Administer student, teacher, and counselor questionnaires and perform student testing	May-June
7	Interview school administrator; collect information about career education programs	June

Staffing

The project data collection team was composed of two groups of people who filled different roles on this task. Eight non-SRI individuals were hired for training as classroom observers, and seven SRI staff members were responsible for the remainder of the data collection activities.

A brief description of the responsibilities and qualifications of these groups follows.

SRI International Staff

The seven members of the SRI data collection team have extensive experience in data collection. They all have backgrounds in education research that ensure an understanding of the principles involved, and they are trained in the specific operations necessary to guarantee the standardization of procedures.

The group was organized with one data collection supervisor and six site coordinators. During the first 6 months of the project, the site coordinators were responsible for overseeing the administration of student, teacher, and counselor instruments; observing the school environment and atmosphere; and conducting interviews with eight geometry students and the school administrators. The site coordinators participated in several in-house briefing sessions conducted by project leaders and consultants. In these sessions, protocols were established and rehearsed for building rapport with site contact persons, teachers, principals, and students; for administering instruments; for interviewing students and administrators; and for conducting ethnographic observations of the school environment.

Classroom Observers

Eight non-SRI personnel were hired for the position of classroom observers, and two SRI staff were trained as relief observers. Two of the eight had been nominated by participating districts as observers whose presence in the classroom would be accepted by target teachers. Two of the eight non-SRI observer candidates did not qualify as data collectors at the conclusion of their training.

All of the remaining observers have college degrees, but more important, all have a strong interest in the study. During the spring data collection period, all exhibited a high degree of professionalism. Because of their demonstrated competence many observers were asked to perform other functions normally carried out by SRI site coordinators.

Training of Classroom Observers

Pretraining Activities

Those selected as observers received a home training kit 7 days before the observation training session. Trainees were required to memorize the definitions and to have a thorough understanding of all codes on the first day of training.

Training

Observation training sessions began on April 13 at SRI in Menlo Park, with 10 trainees in attendance for the 7-day session. Two of the trainees were SRI staff who were trained as relief observers should an emergency arise that required an extra observer. Two trainers conducted the training session, allowing for a ratio of one trainer per five trainees.

During the training session, the trainees were exposed to as many different classroom situations as possible, discussion as to how these events would be coded on the observation system was encouraged. Most of the training time consisted of showing videotapes of secondary math classrooms, coding the tapes with the observation system, and discussing any questions or problems that arose from coding. On the third, fourth, and fifth mornings, trainees conducted practice observations in high school math classrooms in the Menlo Park/Palo Alto area. These practice observations were one class period long. The trainees then returned to the training room and discussed coding problems that had arisen during the practice observation.

In addition to coding from videotapes and the practice classroom observations, trainees were assigned coding exercises to complete in the evening. These exercises were dialogues of classroom situations. Each morning the work from the previous evening was reviewed and discussed.

Throughout the training session, reliability checks were conducted. The trainees and trainers would code a videotape and a tally would be made of the frequency of each code used by each observer. This procedure

assisted the trainers in identifying specific code(s) on which individual trainees needed additional help.

On the seventh morning, a set of reliability tapes was shown. All were tapes of math classroom situations not seen previously by the trainees. To provide as many examples as possible of different codes to test reliability, the videotapes were developed from several sets of classes. To test coding, freeze frames were added to the tapes and observers were told to code the interaction occurring at the freeze frame. The SRI trainers had coded the tapes prior to showing them to the trainees. Coding by the trainers was used as the criterion, and trainees were expected to reach at least 70% agreement with the criterion coding. In the afternoon, observers were given feedback on the reliability coding of the morning. The trainers showed the tapes again and trainees viewed the tapes while looking at their coding. Any incorrect coding was discussed at that time.

At the end of the seventh day, observers were given schedules, materials, and envelopes for returning data to SRI. Suggestions were made for establishing and maintaining rapport with the school administrators, the teachers, and students. Observers were told not to comment on teachers or students to any school personnel, since remarks could be misinterpreted and cause problems. Observers were instructed to call SRI for clarification if they were unsure about any procedure.

Observer Reliability

Procedures

Prior to the training session, SRI trainers contacted math teachers in the Palo Alto area to ask their permission to videotape their classrooms. After the tapes were made, the SRI trainer selected specific tapes to be used for determining observer reliability. These tapes were carefully reviewed by the trainers, in order to have as many examples as possible of the observation codes. The basis for the selection of these tapes was:

- The clarity of the tapes, both visual and auditory.
- The variety of behaviors occurring and subsequently the variety of codes required for correct coding of the tapes.

To ensure that all observers would be coding the same event, original video was copied with freeze frames recorded at those behaviors that were to be coded by the observers. The criterion coding was established from these tapes.

When the trainee observers were shown the criterion-coded videotapes, they had not seen the tapes previously, and no discussion of the tapes was allowed during their viewing and coding, which required 3 hours. Six different sequences were shown. Each sequence was first shown at normal speed, which the observers were told to watch and not to code. The same sequence was then reshowed with freeze frames, and observers told to code the behavior occurring at each freeze.

After all sequences were viewed and coded, the observers were allowed to leave the training room, and the trainers evaluated each observer's coding against the criterion. The trainers calculated the percentage correct for each code by each observer. Any code percentages below 70% were noted, and the trainers reviewed the observers' coding with them. Any cases where observers coded less than 70% correct on a specific code were discussed. Videotapes of examples of the codes in question were then shown. When necessary, the observers were asked to code these tapes and demonstrate, to the trainer's satisfaction, their ability to use the code correctly. Two of the ten trainees were not qualified to collect data for the present study.

After two weeks of data collection, the observers were reshowed four of the six segments on the criterion-coded videotapes to verify that reliability was being maintained.

Results

Table 4 identifies the percentage correct for each code by individual observer. These figures reflect the observers' coding of the criterion-coded videotapes on day 7 of the training session. The last two columns

Table 4
TRAINING RELIABILITY

Criterion Coding	Observer																	
	01		02		03		04		05		06		07		08		X	
	Correct No.	%	Correct No.	%	Correct No.	%	Correct No.	%	Correct No.	%	Correct No.	%	Correct No.	%	Correct No.	%	Correct No.	%
172	171	99	166	97	166	97	169	98	172	100	164	95	164	95	169	98	167.6	97
153	152	99	151	99	148	97	150	98	153	100	147	96	151	99	149	97	150.1	98
5	5	100	5	100	5	100	5	100	5	100	5	100	4	80	5	100	4.9	98
25	24	96	24	96	24	96	25	100	25	100	25	100	24	96	25	100	24.5	98
4	4	100	1	25	0	0	3	75	2	50	3	75	3	75	2	50	2.3	58
4	4	100	3	75	3	75	3	75	4	100	3	75	2	50	4	100	3.3	83
31	23	74	29	94	25	81	27	87	29	94	31	100	24	77	30	97	27.3	88
38	32	84	35	92	34	89	36	95	37	97	31	82	34	89	35	92	34.3	90
4	4	100	4	100	4	100	4	100	4	100	4	100	4	100	4	100	4.0	100
8	5	63	4	50	6	75	5	63	7	88	7	88	7	88	6	75	5.9	74
15	15	100	15	100	14	93	14	93	15	100	14	93	14	93	14	93	14.4	96
7	7	100	7	100	4	57	7	100	7	100	7	100	7	100	4	57	6.3	90
4	4	100	4	100	2	50	4	100	4	100	4	100	4	100	4	100	3.8	95
3	3	100	0	0	3	100	3	100	3	100	2	67	3	100	2	67	2.4	80
9	7	78	7	78	7	78	9	100	8	89	7	78	8	89	7	78	7.5	83
4	4	100	4	100	4	100	4	100	4	100	4	100	4	100	4	100	4.0	100
2	2	100	2	100	2	100	2	100	2	100	2	100	2	100	0	0	1.8	90
1	1	100	1	100	1	100	1	100	1	100	1	100	1	100	0	0	.9	90
147	145	99	143	97	145	99	143	97	147	100	147	100	145	99	143	97	144.8	99
6	5	83	6	100	6	100	5	83	6	100	6	100	5	83	6	100	5.6	94
18	11	61	9	50	12	67	14	78	16	89	14	78	11	61	16	89	12.9	72
3	2	67	1	33	2	67	2	67	2	67	2	67	2	67	1	33	1.8	60
6	1	17	5	83	2	33	5	83	2	33	3	50	5	83	4	67	3.4	57
3	0	0	0	0	2	67	3	100	2	67	3	100	1	33	0	0	1.4	47
3	0	0	1	33	0	0	3	100	2	67	0	0	0	0	2	67	1.0	33
3	3	100	3	100	1	33	2	67	3	100	3	100	3	100	1	33	2.4	80
5	5	100	3	60	5	100	5	100	5	100	5	100	4	80	5	100	4.6	92
100	96	96	82	82	72	72	60	60	99	99	86	88	74	74	62	62	79.0	79
5	5	100	4	80	2	40	2	40	4	80	4	80	2	40	4	80	3.4	68
1	1	100	1	100	0	0	1	100	1	100	1	100	1	100	1	100	.9	90
5	3	60	4	80	3	60	5	100	5	100	5	100	3	60	3	60	3.9	78
14	10	71	14	100	11	79	14	100	12	86	11	79	14	100	14	100	12.5	89

* A for Observation Instrument and coding definitions.

of the table contains the mean frequency and percentage correct across all eight non-SRI observers. The Who and To Whom codes have not been listed individually because the accuracy rate for these codes is extremely high.

In the What codes, Table 4 reveals that when viewing the criterion-coded tapes, two observers (02 and 03) did not distinguish between the IQ (direct question) and 2 (open-ended request) codes. The confusion was because of difficulty in hearing the videotapes. With additional training, these two observers demonstrated competence in the use of the codes to the trainers' satisfaction. One observer (07) did not reach the required reliability for the clarifying question (2Q) code, incorrectly coding it as direct question (IQ).

One observer (02) did not reach the 70% reliability for the activity-related comments or actions (6) code. The observer had incorrectly coded two examples on the videotapes as responses (3). Since the difference between these codes is stressed throughout the training, the trainers spent a great deal of time with this observer to be certain that the concept was understood. The same observer also demonstrated a lack of understanding of the response code (3). After several individual feedback sessions, the observer demonstrated an understanding of this code and was allowed to collect data.

In the How codes, the observers were not able to reach a 70% reliability for the guiding code (G). This code represents a specific type of corrective feedback (C). Previous training sessions have indicated that a low percentage correct on this code may be the result of lack of clarity on the videotape and not a confusion in the correct use of the codes. Because the use of this code is infrequent, incorrectly coding only one example may cause an observer's reliability to be below 70%.

The codes for laughter (L) and warmth (W) were very low frequency and some observers had low reliability in coding these. By combining these two codes into positive affective, the frequencies increased, as did the reliability.

The last column of Table 4 shows the percentage correct across all observers. All the What codes are 75% or greater. In the How section, the guiding (G), specific (S), and positive expectations (P) codes are less than 70%. These are infrequent behaviors and the available examples were not clear, which made interpretation difficult. Any analysis using these codes must be performed with caution.

Table 5 shows reliability of observers after collecting data for 2 weeks. Because observers were still collecting data when this reliability check was conducted, their observation schedule did not allow for a block of time when all observers were available for the 3 hours necessary to code the six segments of the criterion-coded videotape. Therefore, four segments of the original six were shown to them. It was felt that this would be sufficient to determine if observers had maintained the level of reliability that was present at the end of training. The percentages shown in Table 5 indicate that observers were able to maintain their reliability level, with some improvement in the What codes. Three of the How codes that were below reliability at the end of observation training were also below reliability at the reliability check--warmth (W), specific (S), and positive expectation (P). The videotape segments selected for this reliability check did not contain any examples of the guiding code (G).

The Data Collected

The Spring 1978 data collection effort spanned approximately 9 weeks from April to the middle of June. Field activities included three distinct phases:

- Classroom observation
- Administration of tests and questionnaires
- Interviews.

Each participating classroom was observed three times during a 3-week period beginning in late April. Eight observers were rotated to the various schools so that no one observer spent all of his or her time at one school. The observations were successfully concluded with far less

Table 5
POST-TRAINING RELIABILITY

Code*	Criterion Coding	Observer																	
		01		02		03		04		05		06		07		08		X	
		Correct No.	%	Correct No.	%	Correct No.	%	Correct No.	%	Correct No.	%	Correct No.	%	Correct No.	%	Correct No.	%	Correct No.	%
HO (ALL)	75	72	96	74	99	73	97	73	97	74	99	72	96	72	96	72	96	72.8	97
TO WHOM (ALL)	72	72	100	72	100	68	94	72	100	72	100	72	100	71	99	71	99	71.3	99
BIAT																			
1	4	4	100	4	100	4	100	4	100	4	100	4	100	4	100	4	100	4.0	100
1Q	8	8	100	8	100	8	100	7	88	8	100	8	100	8	100	8	100	7.9	99
2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2Q	3	3	100	3	100	2	67	3	100	3	100	2	67	2	67	2	67	2.5	83
3	11	11	100	11	100	11	100	11	100	11	100	11	100	11	100	9	82	10.8	98
4	13	13	100	13	100	11	85	13	100	13	100	12	92	13	100	12	92	12.5	96
5	1	1	100	1	100	1	100	1	100	1	100	1	100	1	100	1	100	1.0	100
6	6	6	100	6	100	3	50	5	83	6	100	5	83	6	100	6	100	5.4	90
7	5	5	100	4	80	5	100	5	100	5	100	3	60	5	100	4	80	4.5	90
8	5	4	80	5	100	4	80	5	100	5	100	4	80	5	100	4	80	4.5	90
9	2	2	100	2	100	2	100	2	100	2	100	2	100	2	100	2	100	2.0	100
10	1	1	100	0	0	0	0	1	100	1	100	0	0	0	0	0	0	.4	40
11	5	4	80	4	80	3	60	5	100	5	100	4	80	4	80	4	80	4.1	82
12	3	3	100	3	100	2	67	3	100	3	100	3	100	3	100	3	100	2.9	97
X	2	2	100	2	100	2	100	2	100	2	100	2	100	2	100	1	50	1.9	95
T	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R/M	54	54	100	54	100	54	100	54	100	54	100	54	100	54	100	54	100	54.0	100
B	4	4	100	4	100	4	100	3	75	4	100	4	100	4	100	4	100	3.9	98
C	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
G	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
O	5	5	100	5	100	5	100	4	80	5	100	4	80	5	100	4	80	4.6	92
L	3	1	33	2	67	2	67	2	67	2	67	2	67	3	100	2	67	2.0	67
W	2	0	0	1	50	1	50	1	50	1	50	1	50	0	0	1	50	.8	40
S	2	0	0	2	100	2	100	2	100	2	100	2	100	2	100	2	100	1.8	90
N	4	4	100	4	100	3	75	4	100	4	100	4	100	3	75	4	100	3.8	95
D	29	28	97	29	100	27	93	24	83	26	90	20	69	29	100	28	97	26.4	91
P	3	2	67	2	67	1	33	3	100	3	100	2	67	2	67	1	33	2.0	67
I	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
T	2	1	50	2	100	2	100	2	100	2	100	1	50	2	100	1	50	1.6	80
NV	9	9	100	8	89	9	100	9	100	9	100	9	100	8	89	8	89	8.6	96

See Appendix A for observation instrument and coding definitions.

than the average amount of rescheduling as a result of the full cooperation of participating teachers.

The second data collection phase immediately followed the classroom observations. SRI site coordinators gave questionnaires to teachers and counselors and administered the four instruments listed below to students in participating classes:

- Student Questionnaire.
- Space Relations Subtest of the Differential Aptitude Tests.
- Student Rating Scale of Instructors.
- A course specific achievement test (e.g., geometry) from the Cooperative Mathematics Test Battery.

A breakdown of the number of students who completed each instrument is presented in Table 6. The number of students completing each instrument varied. Some of the students were absent on the second day of testing, and some who were absent for the first day were present for the second day. Others omitted crucial items.

Confidentiality Procedures

The major concerns of data collection and analysis are confidentiality of data and the right of privacy of the subjects involved in the Women and Math study. SRI considers it of prime importance that stringent procedures are developed and followed to ensure the security of data. Accordingly, the following principles and procedures were adopted:

- All project staff (SRI, site coordinators, classroom observers) were informed of the trust placed in them when they gather data, and were made aware of the nature of their job responsibilities. All staff members signed statements acknowledging the right to privacy of subjects participating in the study.
- Information for identification by name of students from whom data are collected is not available at SRI. A master list of students' numbers, kept by SRI, links students to classrooms.
- Every effort was made to ensure against any unauthorized use of data collected during the study. Information identifying individual teachers by name is not available to the school district or the state department.
- The SRI data bank will be accessible only to authorized personnel and only by a code system.

Table 6

DATA COLLECTED, SPRING 1978
TOTAL SAMPLE

Instrument	Number of Individuals Completing Instrument							School Level	Total
	General Math	Algebra I	Geometry	Algebra 2 Trigonometry	Pre-Calculus	Calculus	Other		
Student Questionnaires	314	361	489	429	247	91	69	--	2,117
Student Rating Scale	314	361	581	454	247	91	69	--	2,117
Instructors									
Operative Mathematics	202	295	366	275	145	72	--	--	1,355
Test Battery									
Force Relations Subset	226	298	381	276	145	82	57	--	1,465
Student Interviews	--	--	65	--	--	--	--	--	65
Classroom Observations	18	15	22	18	10	6	4	--	91
(Classes observed)									
Teacher Questionnaires	16	13	19	15	8	4	1	--	76
Counselor Questionnaires	--	--	--	--	--	--	--	53	53
Administrator Interviews	--	--	--	--	--	--	--	11	11

These guidelines did not place a burden on school district personnel, whose cooperation was essential for successful completion of the data collection activities.

V ANALYSES/FINDINGS

This section describes how the five hypotheses stated in Section III were studied and whether or not our hunches were confirmed. Also included is a section comparing the instruction provided in Type I (general math, pre-algebra), Type II (algebra I, geometry), and Type III (algebra II, trigonometry, calculus) classes.

Students' Reported Math Enrollment Plans

To identify factors that promote higher enrollment and encourage more positive attitudes toward mathematics among high school women, we needed first to determine the students' plans for future enrollment in math classes. This future enrollment information was derived from the student questionnaire. Students were asked if they were at that time enrolled in an advanced math class for the summer or fall of 1978. We then compared the men and women students' math plans within the 22 geometry classes for the total sample, and within the four design variables: urban, suburban, schools with high women's enrollment in advanced math classes, and schools with low women's enrollment in those classes.

Percentage of Men and Women Students Presently Enrolled in Math Classes

To confirm the data gathered in our telephone survey regarding the percentage of women enrolled in advanced math classes, we recorded the actual number of women students involved in each math class in our study. The enrollment of women students in math classes in each of the 11 schools is shown in Table 7. The range of percentages of women enrolled in advanced math classes is as great within schools as it is across schools (e.g., School 8 has 60% women in Class 8, trigonometry; and only 17% women in Class 9, calculus).

Table 7
ENROLLMENT OF WOMEN STUDENTS IN MATH CLASSES

Enrollment Type I ^a				Enrollment Type II ^b				Enrollment Type III ^c				Percent Women in Type II and Type III Classes
Percent			N	Percent			N	Percent				
N	Men	Women		N	Men	Women		N	Men	Women		
School 1	30	80.0	20.0	School 1	84	34.5	65.5	School 1	38	52.6	47.4	59.8
Class 1	15	80.0	20.0	Class 3	12	25.0	75.0	Class 7	20	45.0	55.0	
Class 2	15	80.0	20.0	Class 4	25	24.0	76.0	Class 8	14	57.1	42.9	
School 2	55	43.6	56.4	Class 5	25	52.0	48.0	Class 9	4	75.0	25.0	
Class 1	27	44.4	55.6	Class 6	22	31.8	68.2	School 2	33	33.3	66.7	65.1
Class 2	28	42.9	57.1	School 2	93	35.5	64.5	Class 7	20	35.0	65.0	
School 3	55	50.9	49.1	Class 3	17	41.2	58.8	Class 8	13	30.8	69.2	
Class 1	33	54.5	45.5	Class 4	22	22.7	77.3	School 3	79	58.2	41.8	48.2
Class 2	22	45.5	54.5	Class 5	16	43.8	56.3	Class 7	13	53.8	46.2	
School 4	48	43.8	56.2	Class 6	33	36.8	63.2	Class 8	36	44.4	55.6	
Class 1	23	43.5	56.5	School 3	87	46.0	54.0	Class 9	30	76.7	23.3	
Class 2	25	44.0	56.0	Class 3	27	55.6	44.4	School 4	98	62.3	37.7	39.9
School 5	24	58.3	41.7	Class 4	10	40.0	60.0	Class 7	31	45.2	54.8	
Class 1	8	50.0	50.0	Class 5	31	41.9	58.1	Class 8	29	58.6	41.4	
Class 2	16	62.5	37.5	Class 6	19	42.1	57.9	Class 10	22	77.3	22.7	
School 6	31	54.8	45.2	School 4	105	58.1	41.9	Class 11	16	81.3	18.8	
Class 1	13	61.5	38.5	Class 3	26	57.7	42.3	School 5	103	49.5	50.5	50.8
Class 2	18	50.0	50.0	Class 4	27	70.4	29.6	Class 7	30	43.3	56.7	
School 7	86	62.8	37.2	Class 5	26	53.8	46.2	Class 8	22	63.6	36.4	
Class 1	43	62.8	37.2	Class 6	26	50.0	50.0	Class 9	29	48.3	51.7	
Class 2	43	62.8	37.2	School 5	78	37.2	62.8	Class 10	22	45.5	54.5	
School 8	37	54.0	46.0	Class 4	30	30.0	70.0	School 6	80	43.8	56.2	48.4
Class 1	15	40.0	60.0	Class 5	19	42.1	57.9	Class 7	31	41.9	58.1	
Class 2	22	63.6	36.4	Class 6	29	72.4	27.6	Class 8	31	45.2	54.8	
Total Type I	366			School 6	112	57.1	42.9	Class 9	18	44.8	55.2	
Average X		55.5	44.5	Class 3	21	52.4	47.6	School 7	56	64.3	35.7	38.8
Total X		55.2	44.8	Class 4	33	60.6	39.4	Class 7	25	60.0	40.0	
				Class 5	36	52.8	47.2	Class 8	21	57.1	42.9	
				Class 6	22	63.6	36.4	Class 9	10	90.0	10.0	
				School 7	96	59.4	40.6	School 8	96	54.2	45.8	40.8
				Class 3	23	52.2	47.8	Class 7	27	40.7	59.3	
				Class 4	20	65.0	35.0	Class 8	25	40.0	60.0	
				Class 5	28	60.7	39.3	Class 9	17	82.4	17.6	
				Class 6	25	60.0	40.0	Class 10	27	63.0	37.0	
				School 8	105	43.8	56.2	School 9	82	57.3	42.7	42.8
				Class 3	32	50.0	50.0	Class 3	28	57.1	42.9	
				Class 4	17	70.6	29.4	Class 4	18	55.6	44.4	
				Class 5	30	66.7	33.3	Class 5	21	47.6	52.4	
				Class 6	26	73.1	26.9	Class 6	15	73.3	26.7	
				School 9	49	57.1	42.9	School 10	74	67.6	32.4	42.4
				Class 1	29	58.6	41.4	Class 3	19	52.6	47.4	
				Class 2	20	55.0	45.0	Class 4	21	71.4	28.6	
				School 10	51	43.1	56.9	Class 5	19	63.2	36.8	
				Class 1	28	50.0	50.0	Class 6	15	86.7	13.3	
				Class 2	23	34.8	65.2	School 11	70	54.3	45.7	50.0
				School 11	34	41.2	58.8	Class 3	18	55.6	44.4	
				Class 1	23	52.2	47.8	Class 4	19	57.9	42.1	
				Class 2	11	18.2	81.8	Class 5	26	53.8	46.2	
				Total Type II	894			Class 6	7	42.9	57.1	
				Average X		49.4	50.6	Total Type III	809			
				Total X		50.7	49.3	Average X		56.9	43.1	
								Total X		55.3	44.7	

^a General Math, Pre-algebra.

^b Algebra I, Geometry.

^c Algebra II, Trigonometry, Calculus.

The actual percentage of women enrolled is higher than most schools reported for the Type II and Type III math classes in the telephone survey. Compare the percentages reported by schools in Table 7 with those reported in Table 1. School 3 is greater by 10 percentage points and School 11 is greater by 9 percentage points. These differences might result from three causes: (1) our sample which was not randomly selected, might have uncovered nonrepresentative results; (2) schools might tend to underestimate the number of women enrolled in advanced math classes; and/or (3) the telephone survey estimates, which were based on data available at the start of the school year, might have been different from information available at the date which our data were collected.

Percentage of Men and Women Students in Geometry Classes
Planning to Enroll in Another Math Class

Since the focus of this study is upon the decision to take advanced mathematics, we limited our analysis of this question to 22 geometry classes located in the 11 schools. The reason most often given by men and women taking algebra I and geometry was to meet university requirements. Thus, the most pertinent question is why they continue math studies beyond geometry. In order to study this question we had to know what students were continuing in math studies.

Table 8 shows the contrasts of men and women who are presently enrolled in geometry who intend to take more advanced mathematics. These

Table 8

PERCENTAGE OF MEN AND WOMEN CONTINUING
WITH ADVANCED MATHEMATICS

	Number Presently Enrolled	Continuing in Math (%)	Not Continuing (%)
Women	231	78	22
Men	258	89	11

data indicate that of the 489 students taking geometry who completed the questionnaire, 47% were women. Of that 47%, approximately 78% were planning to continue with mathematics. Although there is about an equal number of women as men taking geometry, twice as many women as men do not plan to continue in math studies.

Through a discriminant function analysis substantiated by analyses of variance, significant differences ($p > .05$) were found in the following factors influencing the continuation of women and men: The men who were continuing reported more parent support of taking advanced mathematics and their parents had higher expectations. Women reported speaking less often to their math teachers and feeling more anxiety about mathematics than did the men (see Table 9).

Hypothesis #1: Comparison of Women Who Continue in Mathematics with Those Who Do Not

Factors (parents, peers, teachers, counselors, programs, potential careers or college plans) identified by students as most influential in their decision to enroll or not to enroll in an elective math class will be identified and they will vary by school, location and by high and low involvement of women in advanced math classes.

This hypothesis was tested by conducting discriminant function analyses and analyses of variance that compared the student questionnaire responses of groups of women choosing to take advanced mathematics with those choosing not to take advanced mathematics. The manner in which questionnaire items were scaled is presented in Appendix C. The results of these analyses follow.

Women who decided to continue in mathematics (189) were compared with women who decided not to continue (42). Variables were used from the student questionnaire, Student Rating Scale of Instructors, space relationships test, and the geometry achievement test. Student interviews were used to document in more detail possible school influences. Table 10 indicates variables that discriminated between the two groups of women students.

Table 9

COMPARISON OF WOMEN WHO ARE CONTINUING MATHEMATICS
WITH MEN WHO ARE CONTINUING*
(For all geometry classes
across all 11 schools)†

Variable of Interest	Women Continuing N=189		Men Continuing N=230		Contrast P Value
	$\bar{x}$	S.D.	$\bar{x}$	S.D.	
Talk to math teacher	1.42	2.13	3.39	6.20	.06
Spatial ability	16.06	5.37	18.45	5.52	.06
Math anxiety	.29	.42	.50	.43	.04
Father support for taking mathematics	.89	.29	.98	.04	.10

* These variables comprised the discriminant function that identified factors that differentiated between continuation and no continuation. This is an analysis of variance on those factors.

† All contrasts significant at $\alpha \leq .10$ are reported. These are contrasts of interest; they are not to be reported as significant at .1 as we are doing multiple tests.

Table 10

COMPARISON OF WOMEN WHO ARE CONTINUING
MATH STUDIES WITH THOSE WHO ARE NOT
(For all geometry classes
across all 11 schools)*

Variable of Interest†	Women Continuing N=189		Women Not Continuing N=42		Contrast P Value
	$\bar{x}$	S.D.	$\bar{x}$	S.D.	
Would not take a mathematics class from a teacher they didn't like	1.60	.49	1.75	.43	.06
Prefer a male teacher	.29	.43	.15	.50	.07
Rate teacher professional	32.80	4.80	30.60	5.90	.03
Difficulty with mathematics	.58	.48	.77	.41	.02
Math anxiety	.46	.49	.73	.44	.001
Space relationships test	21.10	5.60	19.10	5.60	.03
Father support for taking mathematics	.96	.18	.88	.33	.04
Mother support for taking mathematics	.98	.13	.93	.26	.04

* All contrasts significant at $\alpha \leq .10$ are reported. These are contrasts of interest; they are not to be reported as significant at .1 as we are doing multiple tests.

† These variables comprised the discriminant function that identified factors that differentiated between continuation and no continuation. This is an analysis of variance on those factors.

The women who plan to continue in math studies have more father and mother support. They find math courses less difficult, have less anxiety, and higher scores on the space relationships test. Although they are more likely to take a math class from a teacher they don't like, they prefer men teachers and rate their present math teachers higher than do the women who are not continuing in mathematics. The discriminant function analysis using these variables classified 81.8% of the women students correctly as to whether they were or were not continuing in math studies, giving support to the importance of these factors in influencing the decision to continue in mathematics.

Results from a discriminant function analysis and several analyses of variance comparing women geometry students who plan to continue taking mathematics with those who do not in several school populations are displayed on Table 11. Differences in women continuing and not continuing with math studies are reported at $p > .10$ for high and low enrollment schools and for urban and suburban schools.

The 69 women continuing math studies in low enrollment schools reported more mother support and less math anxiety than did the women not continuing. Those continuing also had higher scores on the geometry test and the space relationships test.

The women continuing math studies in high enrollment schools reported higher parent expectations and education plans that required more mathematics. Similarly, the women continuing math studies in both urban and suburban schools reported higher parent expectations, more father and mother support of taking mathematics, and less math anxiety.

Student Interviews

Student interviews contributed further information regarding why some students take advanced mathematics while others do not. Of the 65 students interviewed in geometry classes, 38 were women. Nineteen of these women were planning to enroll in advanced math courses. The women's responses are discussed below.

Table 11
COMPARISON OF WOMEN WHO CONTINUE MATH STUDIES WITH THOSE WHO DO NOT
FOR GEOMETRY CLASSES IN VARIOUS SCHOOL POPULATIONS

Variable of Interest *	Women Continuing			Women Not Continuing			Contrast P Value [†]
	N	$\bar{x}$	S.D.	N	$\bar{x}$	S.D.	
Low Involvement Schools (N=82)	69			13			
Geometry achievement test		15.70	3.00		13.30	3.20	.010
Space relationships test		22.20	4.50		17.20	5.10	.002
Rate teacher professional		32.80	5.00		36.00	2.50	.030
Math anxiety		.51	.50		.92	.28	.005
Mother support for taking mathematics		1.00	.00		.09	.08	.020
High Involvement Schools (N=149)	120			29			
Prefer a male teacher		.14	.46		.40	.63	.070
Parent expectations		4.23	.70		3.81	.78	.040
Educational aspiration and career plans		1.41	.81		.97	.90	.060
Urban Schools (N=93)	81			12			
Talk to math teacher		1.84	3.02		4.50	7.35	.030
Parent expectations		4.27	.64		3.93	.80	.100
Math anxiety		.41	.48		.70	.46	.060
Father support for taking mathematics		.91	.28		.75	.45	.100
Suburban Schools (N=138)	108			30			
Would not take math from a not-liked teacher		1.50	.50		1.80	.41	.020
Geometry achievement test		16.50	2.60		15.20	2.50	.010
Space relationships test		23.10	4.50		20.20	5.70	.004
Rate teacher professional		30.70	5.90		34.00	3.70	.005
Rate teacher personal attention		23.20	5.60		25.50	4.00	.040
Math anxiety		.49	.49		.74	.43	.010
Difficulty with mathematics		.55	.48		.79	.41	.010
Positive experience with mathematics		.97	.16		.90	.30	.090
Father support for taking mathematics		1.00	.00		.93	.25	.010
Mother support for taking mathematics		2.00	.00		.93	.25	.010

* These variables comprised the discriminant function which identified factors that differentiated between continuation and no continuation. This is an analysis of variance on those factors.

† All contrasts significant at $\alpha < .10$ are reported. These are contrasts of interest; they are not to be reported as significant at .1 as we are doing multiple tests.

There were no distinct differences in student responses between the schools or within schools; responses from the men and women students were surprisingly consistent. Unfortunately, we did not include any interview items that specifically asked about parental influence. We did not foresee that this might be an important factor and instead focused the interviews upon school issues.

Reasons for Taking or Not Taking More Mathematics

Of the women who planned to take advanced math courses, 75% said the main reasons for enrolling were that they liked mathematics, that it came easily to them, and that they did well in their math courses. Sixty percent of the women continuing with math studies noted that taking advanced mathematics would allow them to enter particular college programs. Two-thirds of the women who are not continuing with their math education stated that mathematics is difficult for them, that they do not like mathematics, and that it is not relevant in their intended careers.

Difficulty of the Coursework

Fifty percent of the women taking advanced mathematics cited their favorite course as algebra I and the other 50% favored geometry. Considering their entire course load, these women perceived their math courses to be harder and more challenging than other courses. In fact, most of the women interviewed perceived mathematics as a difficult subject, but those continuing found it challenging, not overwhelming.

Influence of Significant Others

Teachers --The students interviewed reported no preference in the sex of their math teachers. Students do prefer a teacher who 1) explains clearly and knows the material, 2) gives plenty of individual instruction, 3) helps students outside of class period, and 4) maintains order. All of the students agreed that the math teachers in their school were as good if not better than the rest of the faculty. Of the women interviewed, 43% never met with their math teacher outside of class. Another 43% of the women sought assistance and advice with difficult math test items. Of the men, 67% reported meeting with their math teachers.

Counselors--All of the women interviewed met with their counselors during the school year. The major reason for the meeting was to discuss class schedules. Only one woman noted that her counselor encouraged her to continue in mathematics. Several women discussed career plans with their counselor but few felt that counselors had any impact on whether or not they would continue to enroll in math classes.

Perceived Utility

Most female interviewees acknowledged the usefulness of mathematics in their daily activities (e.g., calculating taxes, buying groceries, banking). The women who are continuing see that mathematics is necessary and useful in their planned careers (e.g., architecture, psychology, law). Those not continuing have chosen careers in art, dance, and music and do not see the usefulness of mathematics. They also do not want to confound their class schedules with "unnecessary" courses.

Men's Interview Responses Compared to Women's Responses

The men students who were interviewed responded similarly to the women interviewees. Those continuing with mathematics said that they liked mathematics, it was easy for them, and it was required in their college plans. Those not continuing found mathematics difficult, did not like it, and did not see it as useful to their careers.

Discussion

The factor from the student questionnaire, student ratings and test data that is found most often to differentiate the women continuing in mathematics from those who are not is parent expectations and parental support in taking advanced mathematics. Prior research suggested that parental encouragement of women to enroll in advanced math classes is crucial but often absent (Aiken, 1972a; Haven, 1971; Fennema and Sherman, 1977a). Our data suggest that parents are perhaps the most important factor for women as well as men in continuing with math studies.

Women continuing did rate their math teachers as being more professional than did those not continuing but they also said they would take a class from a teacher they didn't like. However, teacher influence was not one of the most highly rated influences on their decisions to continue in math studies. Nor did women students credit peers, counselors, or school programs as important in affecting their math enrollment decisions.

Women who were continuing in math studies had more spatial ability, higher achievement test scores, more positive feelings about mathematics, and less anxiety. Thus, we must conclude that attitude and aptitude are factors in women's continuing in math studies.

Other researchers have reported that women tend to underestimate their intellectual abilities and lack self-confidence, resulting in math anxiety (Ernest, 1976; Levine, 1976). However, the women in this study who planned to continue in math studies reported that they like mathematics, they are good at it, and it is necessary for careers they have chosen. This population of women responded differently than those described by Ernest, 1976; Fennema and Sherman, 1977b. They did not perceive mathematics as a male domain.

Hypothesis #2: Difference between Women's and Men's Math Aptitude and Achievement in Advanced Math Classes

The second hypothesis stated that a positive relationship would be found between math aptitude and ability and decisions to continue in advanced math classes; further, that men and women enrolled in advanced math classes would have similar math aptitude and achievement scores.

To examine the relationship between math aptitude and math achievement, correlations were computed for each level of math test with the space relationships test. The results of these computations are presented on Table 12. There are significant correlations for men and women between spatial ability and math achievement above the level of arithmetic. There are significant correlations for women at all levels but curiously not for men in either algebra II or calculus.

Table 12

CORRELATION OF SPACE RELATIONSHIPS AND ACHIEVEMENT TESTS

Tests	Overall		Men		Women	
	r	p	r	p	r	p
Calculus	.02	--	.17	--	.57	.01
Analytical Geometry	.68	.001	.70	.001	.60	.001
Trigonometry	.38	.001	.27	.01	.50	.001
Algebra II	.15	.01	.05	--	.24	.01
Geometry	.53	.001	.49	.001	.52	.001
Algebra I	.49	.001	.50	.001	.45	.001
Arithmetic	.11	--	.20	--	.03	--

Men scored higher than women on the achievement tests and space relationships test on all levels except trigonometry and algebra II. (See Table 13.) It must be remembered that with such a large number of students in the sample very small differences of one or two test items may result in significant differences that have little actual meaning.

Discussion

We conclude that the second hypothesis is confirmed in part. There are relationships between spatial ability and math achievement. Similar to the findings of Fennema (1974) and Maccoby and Jacklin (1974) we found men in general to score higher on the space relationships test but not at all levels of testing. We also found that women continuing in math studies scored higher on the space relationships test than did women who did not continue.

We found no difference in achievement scores of men and women in algebra II and trigonometry, but men scored higher in analytical geometry and calculus. This supports the findings of Sherman and Fennema (1977) that men are not invariably superior in math achievement and spatial visualization when the math courses taken are considered.

Hypothesis #3: Classroom Processes Related to Enrollment of Women in Advanced Math Classes

Hypothesis #3 states that particular combinations of classroom processes will be related to high enrollment of women in math classes.

To examine this hypothesis we compared 34 classroom process variables* with women's enrollment in advanced math classes, and we correlated the process variables with enrollment. We focused on the relationship between classroom process variables and the continuation rate for women in the different geometry classes. Nine categories of classrooms were defined based on the percentage of women continuing from geometry into advanced math classes. These percentages ranged from 45% to 100%. Table 14 presents

* See Appendix B.

Table 13

MEANS AND STANDARD DEVIATIONS OF MEN AND WOMEN
ACHIEVEMENT TEST SCORES AND SPACE RELATIONSHIPS
SCORES BY COURSE LEVEL

Course	Achievement Test				Space Relationships Test		
	N	X	S.D.	P	X	S.D.	P
Calculus							
Men	58	10.76	3.28	.01	10.76	3.28	.04
Women	23	8.78	3.94		8.78	3.94	
Analytical Geometry							
Men	37	11.51	3.66	.01	11.51	3.66	.01
Women	32	9.25	3.94		9.25	3.94	
Trigonometry							
Men	106	7.94	3.57	.25	7.94	3.57	.74
Women	100	7.78	3.51		7.78	3.51	
Algebra II							
Men	149	12.95	5.49	.25	12.95	5.49	.71
Women	126	12.71	5.53		12.70	5.53	
Geometry							
Men	248	15.99	3.08	.01	15.99	3.08	.001
Women	223	14.75	3.74		14.75	3.74	
Algebra I							
Men	136	12.81	3.86	.01	13.00	3.78	.04
Women	146	11.88	3.97		12.09	4.00	
Arithmetic							
Men	70	4.00	1.69	.01	4.00	1.69	.05
Women	83	4.53	1.64		4.53	1.64	

Table 14

CLASSROOM CONTINUATION PERCENTAGES BY OBSERVATION VARIABLES

		Group 1 45% [†] (N=1) [‡]	Group 2 62-64% (N=3)	Group 3 70-73% (N=2)	Group 4 75-77% (N=3)	Group 5 80-84% (N=2)	Group 6 85-88% (N=3)	Group 7 89-92% (N=3)	Group 8 95% (N=1)	Group 9 100% (N=5)
Variable		$\bar{X}$	$\bar{X}$	$\bar{X}$	$\bar{X}$	$\bar{X}$	$\bar{X}$	$\bar{X}$	$\bar{X}$	$\bar{X}$
S2	Teacher without student	20.00	22.22	16.67	8.89	13.33	20.00	15.56	20.00	17.33
S3	Assignments	0.0	0.0	0.0	2.36	3.49	0.0	2.28	0.0	0.0
S4	Instructing	13.41	23.90	14.63	23.54	36.51	13.30	23.31	54.92	25.79
S5	Discussion	37.27	17.68	9.90	18.78	20.14	33.56	39.25	3.66	19.61
S7	Written assignments	12.73	23.04	14.58	15.10	16.17	8.06	10.49	13.73	17.56
S8	Test	0.0	3.55	1.84	0.0	3.49	6.17	0.0	0.0	0.24
S10	Social interaction	20.00	13.54	14.83	17.53	9.61	9.39	6.53	0.92	17.95
S11	Student uninvolved	0.68	7.42	9.27	7.05	0.93	8.21	1.76	2.52	4.28
S12	Discipline	6.36*	0.0	0.0	0.36	0.0	0.0	0.0	0.0	0.0
S13	Student management	0.0	0.44	1.97	2.39	2.06	2.78	1.55	0.0	0.0
F1	All female interaction with teacher	9.67	23.11	19.33	13.22	12.67	12.67	16.22	13.00	9.40
F2	All teacher interaction with female	15.67	37.00	31.83	23.78	19.00	18.50	23.56	19.67	24.40
F3	All male interaction with teacher	16.00	18.11	16.17	20.56	11.50	24.17	8.89	10.00	20.67
F4	All teacher interaction with male	23.67	28.89	34.83	31.67	16.00	35.67	15.56	25.00	39.93
F15	All female students question/math	4.67	11.78	4.33	5.89	7.50	4.17	4.78	4.33	4.53
F16	All male students question/math	9.00	8.33	5.50	5.22	5.67	5.00	2.22	3.67	8.53
F18	Teacher questions female student	3.00	4.00	10.17*	3.33	2.00	3.17	5.00	1.33	0.47
F19	Teacher questions male student	2.33	4.00	6.17	6.22	2.17	13.00*	2.56	3.67	2.20
F28	Female student clarifying questions/math	1.00	0.78	0.0	0.78	0.0	0.17	0.44	0.0	0.40
F29	Male student clarifying questions/math	2.33*	1.00	0.0	0.44	0.0	0.50	0.0	0.0	0.27
F34	Female volunteer response	0.67	0.89	0.83	0.78	1.17	0.83	2.11	4.33	0.47
F35	Male volunteer response	1.67	1.00	0.67	4.00	1.00	1.00	1.44	1.00	1.93
F43	Teacher instructs female student	0.0	11.78	7.17	7.44	3.67	4.67	2.56	2.00	4.33
F44	Teacher instructs male student	2.00	6.00	15.17	6.11	4.17	1.67	4.33	14.67	6.73
F54	Teacher social interaction/female stud.	0.0	1.11	2.17	2.33	0.33	0.17	0.22	0.0	0.13
F55	Teacher social interaction/male stud.	0.67	1.11	2.83	5.00	1.00	3.17	0.0	0.0	0.33
F62	Teacher acknowledges female student	2.00	3.00	5.33	2.56	3.33	3.33	3.89	5.33	0.67
F63	Teacher acknowledges male student	2.67	3.11	3.00	7.11	2.83	3.33	3.00	2.00	3.20
F65	Teacher praises female student	0.0	0.22	0.50	0.22	0.17	0.0	0.11	1.67	0.13
F66	Teacher praises male student	0.33	0.22	0.67	0.44	0.0	0.17	0.0	0.67	0.93
F100	Corrective feedback/female student	14.00	5.11	2.33	3.22	5.83	1.00	9.22	9.33	16.33
F101	Corrective feedback/male student	11.67	7.00	3.83	14.00	2.17	12.50	4.44	1.33	23.73
F111	Negative interactions/female student	0.0	0.0	0.0	0.33	0.0	0.0	0.0	0.0	0.07
F112	Negative interactions/male student	0.0	0.0	0.33	0.11	0.17	0.0	0.33	0.0	0.13
	Number of females	13.00	13.00	13.00	11.00	11.50	8.50	15.00	25.00	10.40
	Number of males	17.00	12.33	11.50	8.33	12.50	13.00	13.00	6.00	14.80
	Total number of students	30.00	25.33	24.50	19.33	24.00	21.50	28.00	31.00	25.20
	Percentage of women students	43.3%	51.3%	53.1%	56.9%	47.9%	39.5%	53.6%	80.7%	41.3%

* Significant correlation at .05.

[†] Percentage of women continuing in math studies.[‡] N = Number of classrooms.

the occurrence of the classroom process variable in each of the nine categories. Only four significant correlations were identified (asterisked on Table 14), so few that they could be significant by chance.

If Group 1 with 45% of the women continuing math studies is contrasted with Groups 8 and 9 with 95%-100% continuing, we find a pattern of more instruction (S4, F43, F44) occurring in Groups 8 and 9. Overall, the number of interactions occurring with men and women (F2, F3, F4) in the Groups 8 and 9 are greater than in Group 1. The five Group 9 teachers offered more corrective feedback to men and women (F100, F101) than did all other teachers. Group 1 students received significantly more disciplining (S12) than did all other students. The amount of praise and acknowledgement (F62, F63, F65, F66) is approximately the same for Groups 1 and 9. The Group 8 teacher offered more praise and acknowledgement (F62, F65) to women than did most other teachers but this teacher also had more women students in the class than did all other teachers (25 women out of 31 students).

The number of women students in the classes varied from 8 to 25. The percentage of women in the class might influence women's decisions to continue with math studies. If a large number of women were in the geometry class, educators have speculated that this might be an incentive for women to continue; if only a few women were in the class they might feel strange and not continue. No such trend is seen here. In Group 6 only 39% are women but 85-88% of those are continuing. In Group 2 51% of the students are women but only 62-64% are continuing. Thus we must conclude that peers or the presence of women students does not influence decisions about continuing with math studies. This supports the finding from the student questionnaire that indicated peers had little influence on what classes they take.

Discussion

It does appear that women continue to enroll in mathematics when they are in classrooms that are interactive and instructive. It doesn't matter whether this interaction occurs more with men or women students. It does seem important that an active instructional environment is established. The classroom with the lowest percentage of women continuing had the most

discipline problems and the most social interactions. This indicates more time spent off the task of instructing mathematics. Interestingly, fewer males also continued with math studies from that class. There is little in the literature from previous studies that either substantiates or conflicts with these findings.

Hypothesis #4: Differential Treatment of Men and Women in Math Classes

Hypothesis #4 stated that differential treatment of men and women students would be observed in math classrooms and this will be related to enrollment in advanced math classes. To study this hypothesis we used observation data and statements of teachers on the teacher questionnaires.

Observation

Since geometry classes are the focus of this analysis, they are examined here. There are approximately 50% women in these classes. Therefore, the number of interactions with men and women should be about equal if equal treatment is being given. Table 15 displays the average frequency of observed interactions of teachers with male or female students during a geometry class period. These computations are based upon the total 22 geometry classes in the study.

Though few of the differences are statistically significant, the trend is rather clear. Men are spoken to more often than are women (F10, F11). Men ask more questions (F15, F16) and teachers ask men more questions (F18, F19). Women volunteer answers as often as do men (F34, F35) but the men are called upon to respond more frequently than are women (F40, F41). Men receive a little more individual instruction (F43, F44) and social interaction (F54, F66). Acknowledgement (F62, F63), praise (F65, F66), encouragement (F80, F81) and corrective feedback (F100, F101) are given slightly more frequently to men than to women.

The only variable that occurs more frequently with women is positive interactions (F104), i.e., teachers smile or laugh more with women students than they do with men.

Table 15

MEAN FREQUENCIES OF INTERACTION VARIABLES
FOR GEOMETRY CLASSES

<u>Variables</u>		<u>All Classes</u>
F10	All interaction/female student-teacher verbal, math	38.69
F11	All interaction/male student-teacher verbal, math	46.88
F15	Female student question/math	5.60
F16	Male student question/math	6.59
F18	Teacher question/female student/math	3.72
F19	Teacher question/male student/math	4.60
F34	Female volunteer responses to teacher/math	1.23
F35	Male volunteer responses to teacher/math	1.67
F40	Teacher response/female student question/math	5.49
F41	Teacher response/male student question/math	6.32
F43	Teacher instruction/female student/math	5.48
F44	Teacher instruction/male student/math	6.56
F54	Teacher social interaction/female students	0.97
F55	Teacher social interaction/male students	1.41
F62	Teacher acknowledge female students/math	2.87
F63	Teacher acknowledge male students/math	3.59
F65	Teacher praise female student/math	0.26
F66	Teacher praise male student/math	0.34
F80	Teacher encouraging female student/math	0.23
F81	Teacher encouraging male student/math	0.26
F88	Interaction teacher-female student/relevance of math	0.00
F89	Interaction teacher-male student/relevance of math	0.07
F100	All corrective feedback/female students/math	8.03
F101	All corrective feedback/male students/math	10.13
F104	Teacher positive interaction with female students	0.41
F105	Teacher positive interaction with male students	0.40
F111	Teacher negative interaction with female student	0.06
F112	Teacher negative interaction with male student	0.14

Teacher Questionnaire

To see whether teachers perceived differences in the behavior of women or men students and to see whether we could detect any sex bias on the part of teachers, we arranged the 22 geometry classes into the nine categories described under the analysis of Hypothesis #3. These categories of classrooms were based upon the percentage of women continuing from geometry into advanced math classes. These percentages ranged from 45% to 100%. Table 16 presents how the teachers in the different categories responded to the questionnaire.

The nine geometry teachers who had had 89% or more of their women students enrolled in advanced math classes (Groups 7, 8, and 9) reported that more women than men requested advice about continuing in math studies and that the women students' parents met more often with teachers. Teachers with fewer than 65% women continuing in mathematics (Groups 1 and 2) reported that men requested advice about continuing in math studies more often than women and that the parents of men met more often with the teachers.

All of the teachers felt that men and women were equally good at mathematics and that men and women did not differ in spatial ability. Most of the teachers tended to feel that family, college, or career plans had about equal influence on women's and men's decisions to take advanced mathematics.

Discussion

We conclude that Hypothesis #4 is confirmed in part by the observation data. Overall, men students are treated somewhat differently than are women students in geometry classes. This is in agreement with Bean's finding (1976) that showed teachers initiating more contacts with men students than with women students and with Dweck and Reppucci (1973) who suggest that math teachers provide more feedback to men. Although we found such differences, they did not relate to the enrollment of women in advanced math classes. As stated in Hypothesis #3 discussion, women were more likely to enroll in classes where the instruction provided was actively interactive regardless of whether the introduction was with men or women.

Table 16

TEACHER QUESTIONNAIRE RESPONSES BY PERCENTAGE OF WOMEN CONTINUING IN ADVANCED MATHEMATICS

Variable	Group 1 45% (N=1) ^a	Group 2 62-64% (N=3)	Group 3 70-72% (N=2)	Group 4 75-77% (N=3)	Group 5 80-84% (N=2)	Group 6 85-86% (N=3)	Group 7 90-92% (N=3)	Group 8 95% (N=1)	Group 9 100% (N=3)
number of males seeking teacher's advice about advanced mathematics	4.00	9.00	2.50	18.33	9.00	20.00	16.00	5.00	3.60
number of females seeking teacher's advice about advanced mathematics	2.00	7.67	2.50	18.33	11.00	15.00	19.33	7.00	8.80
number of males/teacher initiated contacts about advanced mathematics	10.00	8.67	4.50	20.33	4.50	33.50	22.67	8.00	6.40
number of females/teacher initiated contacts about advanced mathematics	10.00	9.33	5.50	20.67	3.50	26.00	22.67	8.00	6.40
number of males' parents talked with teacher about mathematics	8.00	15.00	2.50	18.33	7.50	7.50	4.67	6.00	7.60
number of females' parents talked with teacher about mathematics	2.00	15.00	3.50	13.67	4.50	6.50	5.33	8.00	5.40
achievement important for males' advanced math decision	4.00	1.50	2.00	3.00	2.00	3.00	2.67	4.00	2.20
important for males' advanced math decision	4.00	1.67	3.00	1.50	2.00	2.50	2.67	2.00	2.20
achievement important for females' advanced math decision	3.00	2.00	2.50	1.67	2.50	2.00	2.00	2.00	3.25
achievement important for females' advanced math decision	4.00	1.50	2.00	3.00	2.00	3.00	2.67	4.00	2.60
important for females' advanced math decision	4.00	1.67	3.00	1.50	2.00	2.50	2.67	2.00	2.40
important for females' advanced math decision	3.00	2.00	2.50	1.67	2.50	2.00	2.00	2.00	3.25
men have better spatial ability	0.0	0.0	0.0	0.0	0.50	0.0	0.0	0.0	0.60
men are usually better math students	0.0	0.0	0.50	0.33	0.50	0.0	0.50	0.0	0.0
men are usually better math students	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.20
men and women are equally good at mathematics	1.00	1.00	0.0	0.67	1.00	1.00	1.00	1.00	0.80
father's influence on males' decision to study mathematics	5.00	4.00	4.00	4.67	4.00	4.00	4.33	3.00	4.60
mother's influence on males' decision to study mathematics	5.00	4.67	4.50	3.67	4.00	3.50	4.33	4.00	4.60
peer plans' influence on males' decision to study mathematics	4.00	4.67	3.50	3.67	3.50	3.50	4.00	2.00	4.80
father's influence on female decision to study mathematics	5.00	5.00	3.00	4.67	3.50	4.00	4.33	3.00	4.40
mother's influence on female decision to study mathematics	5.00	4.33	4.00	3.67	4.00	3.50	4.33	4.00	4.00
peer plans' influence on females' decision to study mathematics	4.00	4.33	3.50	3.67	3.50	3.50	4.00	2.00	4.40
number of years of mathematics that should be required	2.00	2.00	1.50	2.00	2.00	3.00	2.50	2.00	1.80
reported feelings about teaching	1.00	1.67	1.00	0.67	1.00	1.00	1.67	1.00	1.60
teacher values use of satisfactory GPA in advanced mathematics	22.00	11.00	15.00	12.00	13.00	15.00	14.67	16.00	15.75
plans of all future career and college plans in advanced mathematics	18.00	18.00	15.50	14.67	15.00	14.00	16.67	12.00	17.80
importance of family in advanced math decision	10.00	9.00	7.00	9.33	7.50	8.00	8.67	6.00	9.00

Percentage of women continuing in math studies.

^a Number of classrooms.

The response of teachers on the questionnaires did not indicate any teacher bias. They reported women to be equally good at mathematics as men and that they should be prepared in the same way as men for colleges and careers. This is different than Ernest's finding (1976) that 41% of math teachers felt men did better than women while none felt women did better than men.

Hypothesis #5: Mathematics Related School Program and Counselor Advice

Hypothesis #5 states that schools in which women students are exposed to mathematics-related programs or career education programs will have a higher enrollment of women in mathematics classes than will schools without such intervention. To study this question we interviewed school administrators and career education personnel. Counselor questionnaires also provided data. In our analysis, we examine those programs in each of the 11 study schools.

Urban School 1

School #1, the largest of the six high schools in the district, has a student body of approximately 2,600. Of the students in School #1, 89% are black and only 5% are white. The majority of the families of School #1 students are on AFDC; the average income level of the residents in the attendance area is about \$6,000.

The School #1 Career Center is located in a small corner of the school library where shelves are stacked with college catalogs and some occupational information. The major emphasis of the center, however, is not on careers, but on activities connected with college attendance. Reportedly, the center has received national attention as a model financial aid office.

Historically, career education has received little attention at this school. One attempt to start a viable program was made in 1972 when a program of career exploration was initiated by the Explorer Scouts. The program had been financed by a major local industry and, as it developed, one person had been hired to run the program in each of the district high schools with Vista volunteers providing assistance. However, the program proved to be too narrowly focused and, ultimately, it was abandoned.

Staffing the center is one full-time administrator, a black female now in her late twenties with the title of "Scholarship Office Advisor," who has been with the program for the past 5 years. Although she has no teaching or counseling credential, she has a BA degree. Her salary, equivalent to that of a teacher, is paid by district funds. Although the primary emphasis of the program is on college attendance, the position does involve responsibility for some career-oriented activities: holding occasional career sessions with outside persons as resource speakers, orienting freshmen students to the career center, writing a weekly newsletter, and helping junior students to start a career file.

In the opinion of the center administrator, female students at School #1 have not been provided with appropriate career information, and little attempt has been made to show female students that mathematics is a viable field for women. Overall, she perceives that female students feel that mathematics is too difficult and, seeing no use for mathematics in their future, they tend to drop out of math classes quite early in their schooling.

As the administrator sees it, the major problem is the low level of student motivation and to raise this, outside help is required. Primarily, the need is for the students to see the relevance of education to their future employment. In her view, more resource people are needed to provide information about why technical courses such as advanced mathematics are needed. She also believes students should also be taken out of the school environment more frequently to observe activities in business and industrial settings.

Urban School 2

School #2, the smallest school in our sample with an enrollment of 1,676, is also one of the oldest schools in the district. The student population is over 90% black; the non-black population is predominately Asian.

When School #2 was built in 1914, it received an award for outstanding architectural design. At that time, the expectation was that the school

would house some of the finest technical programs in the country. It was an era when trade schools and vocational education were coming into prominence; in fact, at the time there was a movement to create two separate systems of education, one for vocational, and one for academic schooling.

For a number of years, School #2 produced some remarkably fine technical offerings and many of its graduates went on to outstanding careers. However, the quality of its vocational courses has declined somewhat, although today it offers such contemporary classes as advanced auto repair, drafting, and health occupations.

In keeping with School #2's tradition of excellence, the career center at the school is reported to be one of the best in the Bay Area, at least in terms of programs provided for educationally disadvantaged youth (EDY). The center was started about 3 years ago by the school librarian, who had a special interest in the subject of career information.

In September 1977, under a special Federal grant, School #2 began implementing career education in earnest. Five periods a day were given to career education classes with an average enrollment of 35 students per class. Last year, over 500 students went through the center, which is located in a portable building on the main campus.

Career education classes are arranged as a substitute for social studies every two weeks. The program starts in social studies with each student receiving a packet of career-oriented materials including a resume form, a typical interview format, articles on why employers hire, how to research a job, etc. After becoming familiar with all materials and receiving training in job interviewing, students are taught to use materials in the career center such as the Dictionary of Occupational Titles and college reference books. At the conclusion of the course, students must come to school appropriately dressed and prepared for a formal job interview held with a panel of administrators, counselors, and teachers. Following the interview, the entire class does a critique of the process.

Although job placement is not a function of the career center at School #2, quite a few of the students have been placed in area industries as a result of the training received. Both the career education teacher

and the assistant who staff the program have high expectations that as the program improves, more placements will be made.

No special emphasis has been given to the problem of placing female students in advanced math; at School #2 the career center's major concern is getting all disadvantaged youth interested in basic math as an adjunct to further career training. However, the hope is that next year, the career education classes previously limited to EDY students will be open to all.

In School #2, in addition to the career education program there is a very active Mathematics, Engineering, and Science Achievement (MESA) program, with the result that 63% of those enrolled in higher mathematics were women (in contrast to the 40% in the suburban schools nearer to Stanford University and the University of California, Berkeley).

Upon entering high schools, any students who have taken algebra and who show an interest in mathematics, science, or engineering are invited to take part in the MESA program; no tests are required. Once in the program, special tutors are provided for students who need help and teachers encourage them to stay in the program. High-interest classes are provided with many field trips and speakers to demonstrate how mathematics, science, and engineering function in society. Every effort is made to help the students grasp the practical use of what they learn in books. The success of the program, now 6 years old, can be seen in the fact that 14 black students from School #2 have completed the classes in trigonometry, physics, and chemistry and are enrolled in a 4-year university for Fall 1978. Prior to the MESA program, black students seldom completed higher mathematics courses--at the most, an average of one a year.

Clearly the MESA program should be of interest to other urban schools. Seemingly the girls are taking more advantage of the MESA program than boys since 67% of the population in higher mathematics classes is girls. Girls in other schools may not receive the type of support and encouragement to continue in mathematics such as the girls as well as boys do in these two schools. Two other high schools in the same district with higher social economic status (SES) have a lower percentage of girls enrolled in the higher math classes.

Urban School 3

With an enrollment of 2,200 students, School #3 is 70% black, 20% Asian, and 10% Chicano and other. Of the total number of students, one-third are in remedial math.

Career education at School #3 is extremely limited. There is no designated location where career education facilities are located, although college catalogs may be found on two shelves in the school library. Responsibility for whatever career-related activities do exist has been given to the Dean of Students, a white middle-aged female administrator who has been at the school for the past 2 years. The Dean's duties primarily center on disciplinary problems, but career education was assigned to her because of her strong interest in, and commitment to the concept of career education. During the several years she has been in the school district she has been involved in career education in various ways. For example, while at another district high school she developed a career education curriculum. For the past 2 years, she has been instructing teachers in career education concepts through the University of California Extension Service.

Despite the Dean's background of interest and experience with career education, however, she has been unable to initiate career education practices at School #3. She feels that there are two major obstacles that have inhibited her best attempts to foster a climate conducive to the career education concept of education. First, the Dean's philosophy of career education differs from that of the school district administration. The district, she says, runs career education out of the vocational educational department and believes that career education is merely learning such things as "how to fill out an employment application." As she sees it, career education is life planning. A second major inhibitor to the expansion of career education activities at School #3 is the resistance of teachers who do not believe in the concept and thus will not attempt to infuse career education into their curricula.

She has few interactions with either the mathematics or counseling departments since staff members in these departments are either too busy with their own activities to listen to her, or too resistant to permit

her to spend time in their classrooms. Only one math teacher has been amenable to having her come into the classroom to talk about the relationship of math education to future career opportunities.

Recently, however, for the first time during her two years at School #3, the Dean had occasion to communicate the importance of advanced mathematics to a problem female student who had been referred to her by the mechanics teacher. Instead of taking disciplinary action with the student, the Dean sought out her areas of interest in the mechanics field and had several counseling sessions with the girl, explaining the potential for engineering careers and investigating opportunities at a Bay Area technical institute. As a result, the girl has become an excellent student and two other female students are seeking similar counseling from the Dean.

In the Dean's view, most of the female students in higher mathematics at School #3 are Asian girls who are disciplined by their families to study and work hard for the future. For these girls, there is no time to participate in extra-curricular affairs; they are always home studying.

The Dean feels that there is an urgent need at the school for the kind of career education she has envisioned. She believes that, if properly presented, career education could improve the academic performance of many of the School #3 students. If all basic skills courses such as mathematics were taught in conjunction with career education, it could make a difference in the lives of many under-achieving students. As it is, she is constantly reminded of the lack of meaning in schooling for many of the School #3 students; most of the Dean's time is given to handling the discipline problems of frustrated, bored, unhappy students who see little utility in their education.

Urban School 4

School #4 was built in 1961. Currently, there are around 2,200 students. In a district that is 80% minority overall, this school is 45% white and 32% black, and 23% other.

The career center at School #4 is located in the 8- by 8-foot office of a male counselor who has the title of Director of Career Education.

This responsibility was given to the counselor 5 years ago when each of the school's seven counselors was given an extra duty in addition to the normal load of approximately 350 students.

Career resources at this school are extremely limited, mostly consisting of a few catalogs and testing material stacked on a table in the counselor's office. This has not always been the case. In 1972, a program of career exploration initiated by the Explorer Scouts had its own separate facility at the school. The program had been financed by a major local industry and as it developed, one person had been hired to run the program in each of the district high schools, with Vista volunteers providing the assistance. The program, however, proved to be too narrowly focused, and ultimately it was abandoned.

In 1976, a fire destroyed the building in which the career program had been housed and, since that time, financial considerations and administrative needs for office space have prevented the assignment of any new space for the career education office. Currently, then, all that remains of the original career program is the small office occupied by the counselor.

During the last year, the district has been exerting some pressure on the counselor to initiate career education activities at the school. He believes in the concept of career education, and is anxious to play a more active role, but he sees two major obstacles and as a result, he feels extremely frustrated. First, and most important, is the lack of time; to promote career education he must have released time from his regular counseling load. Second, his philosophy of career education differs from that of the school district administration. Career education at the district level is administered out of the vocational education department and he has antagonized district administrators by complaining about this.

In his normal round of activities, the counselor has little interaction with the mathematics department and sees this as no particular problem. He feels that no special effort needs to be made at this high-SES school to interest females in scientific careers that require advanced mathematics as a prerequisite. As he sees it, fair numbers of

female students are already in advanced math classes and planning to go into such fields as medicine or science; many have parents in professional fields who have encouraged them to do so. Further, he does not believe that his role should include "selling" students on future careers.

Suburban School 5

The enrollment pattern at School #5 is different from others in our sample. It has a student population of 1,665 and draws mainly from an affluent, suburban attendance area; however, a small post-World War II housing project, currently used as low income housing, also feeds into the school. Thus the school is approximately 80% middle and upper income white and 20% low income black.

The career education center at School #5 is housed in its own separate building some distance from the main administration headquarters. The center occupies a large inner work space approximately 50 by 50 feet. It has a well organized library with an abundant supply of occupational and college reference materials. Situated directly off the center are the offices of relevant personnel such as the work experience coordinator.

Managing the career center is a "career guidance technician," a white, middle-aged district employee who took over the position last semester after having worked in the administrative office of the school district for several years. Overall responsibility for the center is given to the Director of Vocational Education for the district and the perceived "success" of the center is, in large part, attributed to his "dynamic leadership."

The career center at School #5 was created in 1968, an outgrowth of the efforts of a counselor at another district high school. Until 1978, Vocational Education funds provided for the operation of the center by a full-time counselor. Funding cutbacks have meant that the center is no longer under the direction of the counseling department. Although the career guidance technician who manages the center is a full-time employee, her salary is small.

Duties of the technician include ordering career and college materials, arranging field trips, administering vocational interest tests to students, and arranging for college and career-oriented speakers.

According to the respondents in the career center, School #5 is unique for its small-school feeling of camaraderie among both the students and staff. Although the school is located in a primarily upper SES area, the 1,650 students enrolled here come from many diverse backgrounds--upper-middle-income, white professional families as well as black ghetto residents. Yet there have been few incidents of racial conflict. The school is described as having a "warm family feeling"; frequently the principal and the custodian are seen lunching together.

Interactions with the counselors at this school were reported to be excellent. The counselors make use of the center's facilities and try to assist as time allows. Earlier in the year, one counselor met a female civil engineer from Teheran and invited her to be a guest speaker at the school's career center activities. A large number of interested female students attended the meeting to hear her describe her experiences as the only female in the engineering department at U.C. Berkeley, and her subsequent return to her own country to work for the government designing highways. Recently, a female speaker from the Institute of Fashion Design strongly advised the female students present to continue in advanced mathematics if they were interested in a career in her field.

Interactions with the math department at School #5 were also said to be excellent. Math students are sent to the center occasionally, to research careers. Here, starting in the sophomore year, each student maintains a folder that includes the results of vocational interest tests and other materials.

The career guidance technician stated that many improvements are needed and suggested the following. More female role models should be invited to the center. More aptitude and personality tests are needed to track the changing interests of female students as they progress through high school. Although in this upper income area it is taken for granted that many females will go into professional careers, there is a

large body of students for whom this is not true. Many come to high school with unpleasant memories of math classes in earlier grades. She feels strongly that elementary and junior high school mathematics should be taught in a way that provides for the development of success feelings. Unless this has happened earlier it's almost too late to change at the high school level.

Suburban School 6

School #6 is a comparatively new high school that is a "typical" suburban California high school; i.e., "finger" buildings of classrooms running off covered walkways in an outdoor, garden environment. It has a student population of 1,558 which is comparatively homogeneous.

The career center at School #6 is located in a large area approximately 50 by 70 feet, well stocked with an abundant supply of reference materials. The center, started in 1972 with Vocational Education Act (VEA) funds, grew out of the interest of the vocational education coordinator for the school district. Prior to that time, the school's career orientation consisted of a few college catalogs in the library.

To begin with, the center started as the headquarters for 25 work experience students. At that time, the only career activities were those related to managing the students in work experience programs, e.g., arranging a few field trips and guest speakers.

Since that time, the work of the center has expanded. Staffing the program are a full time director, who is a former counselor, and a full time paraprofessional. The director's responsibilities still center on the work experience students (there are now 125) and he is required to make at least one visit per semester to each student's work station. In addition, he supervises the work of the paraprofessional and provides information regarding the operation of the Regional Vocational Center (RVC). He frequently goes to all sophomore classrooms with slides and tapes describing the activities of both the work experience program and the RVC. If there is enough interest, field trips to the RVC are arranged.

Because of the director's background, there are close interactions with the counseling department. There is, however, no direct articulation with the math department and there is no push to recruit female students for advanced math classes. The director of the center at this school does not see it as a problem. He believes that attitudes at this school and in this area have been changing and that female students now feel they can do whatever they choose in the way of a career. For example, a major science activity at the school is an engineering day, which is generally attended by several female students. In addition, female students frequently visit major electronic firms in the area to observe workers in their duties.

Suburban School 7

School # 7 is a new high school located in a rapidly growing suburban area. The 2,345 students are predominantly white with a 20% minority population.

The career center at School #7 was established in the fall of 1973, six years after the school was built. The center was Federally funded for the first 4 years, providing funds for obtaining the original materials on career information. In 1977 the Federal funding was terminated and the district now allocates \$50 per year to the center for the acquisition of any new materials. The salary of the career center aide is provided from the school's guidance and counseling budget. The aide is the only salaried position in the center; clerical assistance is provided by student aides.

The center is located in the middle of the campus, next to the social science classrooms. The room is as large as a double-size classroom, tidy and well arranged.

The center is administered by the school's counseling department and the aide works very closely with the counselors. All 9th grade students are administered the Kuder General Interest Test in the career center by the aide. The aide then gives the tests to the student's counselor. Since counselors are assigned to students based on their English classes, the counselors are able to explain the results of the test to the students as a group in the English class. The students are then taken to the career center during an English period for an orientation of the center. They are

assigned a research paper on occupations related to their interests as identified on the Kuder.

The same general assignment is given in the 10th grade. In the 11th grade, students are administered the Kuder Preference Record, and are again assigned a research paper in the center based on the results of their Kuder Preference Record. This program requires the students to visit the career center at least once a year for the first three years of high school.

Other services are available to students at the center. Part-time jobs are posted for the students' information. College catalogs are also available. The center has an array of materials on careers and occupations. Among these is the SRI Occupplan program, which includes testing students to identify fields of interests and a file of occupational briefs related to the various interest fields. In addition to materials offered by private educational publishing firms, the center has a great deal of material distributed by the State Department of Human Resources.

The career center aide arranges to have guest speakers address students on a variety of careers. Notice of these speakers appears in the school bulletin. The career center aide maintains a file on individual student interests, based on the results of their testing. Students whose field of interest is related to a scheduled speaker are sent a notice of the talk.

The daily school schedule allows students to be free from class when guest speakers are on campus. The last period of the day is a 30-minute period during which no classes are in session. During this time, students may see teachers individually or attend special activities. The guest speakers in the career center are scheduled during this period.

The career center aide is especially interested in informing students on nontraditional occupations for women. A woman engineer has spoken in the center during the past year, as well as women who work at nearby IBM. During the data collection, the site coordinator noticed a bulletin board arranged to focus on the theme of alternative occupations for women.

A Career Day is scheduled during the school year. Students may be released from their classes if there is an event which they are interested

in attending. Although it has not yet been scheduled, the chairperson of the science department has requested that a Science Career Day be arranged.

When interviewed, the career center aide felt the services offered by the center could be improved with increased communication between center staff and teachers in various departments. At the time of the interview, there was very little communication with department heads. The aide felt that if the math teachers would suggest some guest speakers for the center, the students' awareness of math careers might be improved. Also, taking an entire math class to the center, as is done in their English class, might stimulate students' interest in math oriented careers.

Suburban School 8

School #8 is located in a wealthy suburban area proximate to the financial center of the region. The 2,400 students are almost all white, with very few minority or bilingual students.

The career center at School #8 is located in a room approximately 20 by 20 feet, directly across from the Principal's office. The center is stocked with a large supply of career information books and college catalogs.

Staffing the center is a middle-aged black woman who came to the center a year ago with the title of "career guidance technician." Prior to that time, she had worked in the district for 3 years on Project Breakthrough, a Federal project that provided funds for exposing minority students to area colleges and industries. It appears evident that the technician's commitment to Project Breakthrough has been transferred to her current assignment. She is enthusiastic and interested in all phases of her work, which includes ordering career and college materials, arranging for college representatives and career speakers to visit the campus.

Assistance to the center is provided by student volunteers who perform miscellaneous duties such as answering phones, filing, and assisting students in finding information. The student workers receive 5 semester credits.

The career center at School #8 was created in 1968 by a counselor who received district permission to operate the center out of a mobile

trailer in back of the school. The program was able to employ one full-time counselor until 1977, when cuts in district funding meant the counselor position could not be retained. Therefore, the present lower-paying technician position was created.

Organizationally, the center is one of the line responsibilities of the Director of Vocational Education for the district, said to be an extremely aggressive leader who is constantly trying to improve the school's career facilities.

Considering the career center's origins in the counseling department and its long history of ties with counselor managers, it is surprising that there was, at the time of the interview, little interaction with the counseling department. According to most sources, however, counselors have little time for any extra activity because of their average case load of 375 students.

During the past year, there also have been no interactions with the math department. According to the center's managing technician, little emphasis has been placed on the importance of getting female students into advanced mathematics. No activities emanating from the career center have been directed to this problem, although one female engineer from the local water district did speak to the mechanical drawing class about the details of her occupation.

The person in this area who appeared to be most interested in the problem of getting female students into advanced mathematics is the Title IX officer for the district. As yet, she has had little interaction with the career center. However, it is said that whenever she has the opportunity, she tells female students the realities of the local situation in higher education. As she describes it, "If you take only 2 years of mathematics in high school, you will eliminate yourself from all but 5 of the 22 major fields of study at the University of California in Berkeley."

The center's manager felt that concerned involvement of the math faculty is needed if the problem is to be attacked in a serious way. Additionally, more female role models should be used as resource speakers. Most importantly, she felt that increased career awareness should be developed in the elementary and junior high feeder schools.

Suburban School 9

School #9 was built in the 1950s, and is typical of schools built at that time. Approximately 1,320 students attend, predominantly from upper-middle income families. The population is mostly white with a substantial Asian enrollment.

The career education center at School #9 is housed in a room approximately 20 by 40 feet, directly adjacent to the offices of the school counselors. The center is administered through the counseling department, and has been since its origin in 1975. Prior to the initiation of the center, there were only a few shelves in the school library where students were on their own to browse through the college and career references that were found there.

The center is now managed by an instructional aide in her early twenties with a B.A. in sociology, who previously had been a camp counselor. No training was provided for the job. Duties of the aide consist of providing all freshman students with an orientation to the career center, handling job references for students, putting out a monthly newsletter to parents, overseeing the operation of the computerized job information system, arranging for career speakers and college representatives, and administering and interpreting occupational interest surveys. The Kuder tests are given to all sophomores and juniors who ask for it, the Career Planning Inventory is given to all freshmen and juniors, and the Strong-Campbell is given to some juniors and seniors.

Other career activities in the school consist of career education classes (given back-to-back with driver education) and an annual career forum organized by students as part of an overall effort to involve students in school activities.

In this upper SES school where 80% of the students expect to go on to college, there are strong linkages with the community. A formalized volunteer program provides parent helpers for career center tasks; early in the fall a tea is held at which the volunteer staff is introduced. One interesting appendage to the career center is the Service Learning

Program housed in the same location. The purpose of this activity is to provide students with exploratory career activities through volunteer work in local government, social agencies, and small businesses. Starting next year, the district will initiate an experimental requirement that all students must perform a certain number of hours in community service. Five of the required units may be satisfied by 80 hours of volunteer work.

The career education program has close ties with the counseling department; counselors frequently bring students to the career center for information as they discuss future career plans.

Interactions with the math department are few, although math teachers occasionally send students to the center to research certain occupations that require mathematics as a prerequisite. According to the career center director, female enrollment in advanced mathematics does not appear to be the problem it might be elsewhere. Many of the parents in the attendance area have advanced degrees, and it is taken for granted that their children will attend college; female students are as apt to choose professional careers requiring mathematics as are male students.

The career center director stated that many more improvements are needed and felt that, primarily, the need is to infuse career education concepts into the math curriculum. To achieve this, the math staff must be more involved in career education. More guest speakers, and more role models (women "who've made it" in science careers) are needed to promote more awareness of opportunities for women in math-oriented occupations. Also, more internships through the Service Learning Center could provide valuable exposure to the demands of scientific jobs.

Suburban School 10

School #10 is approximately 25 years old. The 1,680 students are mainly from white, middle income families.

The career center at School #10 is housed in a room approximately 30 by 40 feet, adjacent to the library and to the counseling department. There is an abundance of resource material in the center: occupational information, college resource material, and a computerized career information system originating in the school district headquarters.

The influence of an active, concerned citizenry is seen in the origins of the center, which was initiated in 1972 by parent volunteers. Leading the effort was a parent who eventually became mayor. Her parental interest in and enthusiasm for career education convinced other parents of the need for a career center, and a sizable group of volunteers manned the center for over 3 years. The first district employee was hired in 1975.

Today, parent volunteers continue to contribute to the work of the center, providing clerical and other assistance to the full-time instructional aide, now in her third year on the job. Although no training was provided for the position, this employee is currently working for an instructional aide degree at a local community college.

Duties of the aide include ordering college catalogs and other resource material, arranging for college representatives and career-oriented speakers, notifying students of speakers in their areas of interest, teaching students to use occupational information catalogs, and assisting them in finding part-time jobs. All freshmen students in math classes are given one full period for a career center orientation and in addition the aide tries to have at least 30 minutes with individual freshman students. A new career activity was started in the fall of 1977 when elective career education classes were offered back-to-back with driver education.

Since the center is under the supervision of the counseling department, there are close ties with the counseling function and students are frequently referred to the center's resources by individual counselors. With the exception of the freshman math class orientations, there are few interactions with the math department.

The enrollment of female students in advanced math classes was not seen as a problem in this relatively high SES area where a good number of parents have advanced college degrees and many are employed in local electronic industries. According to the aide, in this area "there are almost too many activities for students to choose from." There are nearby summer science camps for sixth graders where high school seniors act as instructors, and occasional math workshops at local universities for high school students. It is not unusual for female students to participate in these activities.

Yet, according to the aide, there is a great need at the local school level for role models whom female students can relate to. More women who have been successful in occupational roles requiring advanced mathematics should be brought to the campus from time to time. More infusion of the career education concept is needed in math classrooms. At the present time, a few teachers are very enthusiastic about career education in the curricula; others are resistant.

Suburban School 11

School #11, although in the same district as School #9 and School #10, is substantially older than the other two schools. The building is of Spanish architecture, and the 1,260 students are 50% Spanish surname.

The career education center at School #11 is located in a small alcove of the school library. College catalogs and occupational resource materials are found on easily accessible shelves. Assisting students in locating needed information is a full time career center aide who has been with the center for 10 months. No training was provided for the position, although the aide has a B.A. in sociology.

Major responsibility for the center has been given to the head of the counseling department, a middle aged white woman with an M.A. in counseling from Stanford University. In addition to her regular duties, the head counselor directs and coordinates the activities of both the center and the Regional Occupational Program.

The center began operating in 1972. At that time, the school district provided a small grant designed to promote career awareness in the local student population. In 1973, the Vocational Education Act provided additional funds for informational and testing materials, speakers, and other activities. The overall plan was to have a sequentially run 3-year career program in which students would start a career folder in their sophomore year and add to it each year until, as seniors, they would have a complete skills and interest profile. In addition, there were to be extensive job exploration activities, and the specific level of skills required for different occupations were to be assessed and taught in different classes.

Implementation of these plans, however, was stopped in 1976 when a new school principal with different priorities took over, and orientation of the program was switched away from career to college planning. The center's fairly large office in the counseling department was abandoned and the center was assigned the current small corner of the library.

Although little remains of the original plan, some activities do persist. Career speakers come to the campus on occasion, the director gives an orientation to the career center to all freshman classes, and the school uses the computerized Career Vocational Information System from the county office.

There is some interaction with the math department; math teachers have come to the center and explored the career curricula units that are found here. In the past year, one seminar was organized around the subject "Opportunities for Women in Math"; local women in math-oriented positions appeared on a panel to discuss the relative merits of their occupations.

In the director's view, the biggest determinant of a female student's decision to take advanced mathematics is her prior record of success. The director also stated that other factors in the female's decisions to take advanced mathematics have a lot to do with the traditional choices of the sexes. Traditionally, women (in a more intuitive feeling mode) have gone into the helping professions, while men have gone into the professions requiring more exactness and regimentation. The director has found that the biggest deterrent to female enrollment in advanced mathematics is family pressures and expectations that females will eventually marry and have families.

As for the future, the director saw little chance for advancing the career education program given the present lack of administrative support. She would like to plan and implement more seminars with female role models, and provide female students with more intern type experiences in volunteer jobs such as assisting math teachers in elementary schools. As she sees it, however, the most important need for improvement is at the elementary school level where students must experience success in mathematics, if they are to continue in advanced courses.

Counselor Questionnaires

Fifty-three counselor questionnaires were returned. None of the counselors reported giving different career plan advice to men than to women. They reported that overall women sought more advice than men. They felt that previous grades in mathematics and the advice of math teachers and parents influenced both men and women students the most in making decisions to continue in math studies.

Discussion

All schools in our sample had some sort of career education program for their students. The degree of formality of this program varied from school to school, and primarily between urban and suburban schools. In most of the urban schools (3 of the 4 in our sample), career education seems to be given low priority. Career centers were given a small amount of space and were run by a technician or a counselor who also had numerous other responsibilities within the school. Those in charge of the career education programs reported that communication from the administration and the math department to the career centers is generally limited. Only one urban school reported an active recruitment for their math program. This program in School #2 receives support from the business community. The program does not necessarily encourage women to enroll in mathematics any more than it does men, but this is the school with the highest enrollment of women students in advanced math classes.

In the suburban schools, the picture was somewhat different. Career planning was seen as more important; there was only one suburban school in our sample that stressed college attendance per se over career planning. Career planning in the suburban schools seems to receive more space, a full-time counselor, and better communication with the administration and the math department. However, none of the suburban schools reported active recruitment of women into the math program; nor did they report having programs to encourage women to increase the range of their career choices.

Since there were so few active career education or math programs in our sample of schools, we cannot confirm the hypothesis that relates high involvement of women in advanced mathematics to school career programs--except in the case of School #2. The reason for the higher involvement of women in this urban school may be that these young women, having entered the math program, continue taking mathematics because they do not have the mother role model suburban women have. In suburbia, mothers are likely to have college degrees in liberal arts or social sciences, and if young suburban women follow in their mother's model they do not need advanced mathematics. The young urban woman achieving well in mathematics can aspire to be a doctor, an architect, or physicist since she may be the first in her family to go to college--she creates her own model.

The findings from the counselor questionnaires are different from those reported by Casserly (1975) and Luchins (1976). These researchers reported that some counselors admitted discouraging women students from taking advanced math courses. The counselors in our study made no such admissions. It may be that counselors' stereotyped attitudes are decreasing toward the end of this decade.

A Comparison of Math Activities in Type I, II, and III Classrooms

How math instruction differs from general math classes and geometry classes can be studied with these data. The SRI observers informally reported that general math classes appeared to be much less task-oriented and the teacher seemed less involved in teaching the students. To see whether or not this was true we compared the kinds of activities occurring in the Type I, Type II, and Type III classrooms.

Data from the observation of activities (see Table 17) indicate that Type II and III teachers offer more instruction (S5) and discussion (S6) than do the Type I teachers. They also spend less time doing classroom management tasks during the class period.

Type I teachers have students doing written assignments (S8) three times as often as do Type III teachers. Students in Type I classes were

Table 17

PERCENTAGE OF OCCURRENCE OF ACTIVITY VARIABLES
FOR THREE TYPES* OF MATH CLASSES

Variables	All Classes Type I	All Classes Type II	All Classes Type III
	$\bar{x}$	$\bar{x}$	$\bar{x}$
S1 Teacher class management, no students	23.333	20.360	15.175
S4 Making assignments	0.929	1.039	2.077
S5 Instruction	14.895	25.353	30.512
S6 Discussion	8.091	20.800	23.216
S8 Written assignments	33.755	14.807	11.122
S9 Test taking	3.865	2.147	2.054
S11 Social interaction	10.610	12.672	13.797
S12 Student uninvolved	11.022	6.252	3.471
S13 Discipline	0.262	0.200	0.040

* Type I = General Math, Pre-algebra
 Type II = Algebra I, Geometry
 Type III = Algebra II, Trigonometry, Calculus.

observed to be not involved in any activity (S12) more than three times as often as Type III students. These data indicate that Type I students do not receive as much interactive instruction (S5, S6); they are more often given written assignments (S8) while the teacher does class management tasks such as grade papers or make lesson plans or keep records (S1). In an SRI study of secondary reading classes we found a negative relationship between this type of noninteractive instruction and student achievement. On the other hand, in that same study we found strong positive correlations, .63, between interactive instruction (discussion, S6) and student achievement. This type of instruction is seen in Type II and Type III classes.

A corroboration of this difference in teaching in Type I classes and Type II and III classes was found when we compared the teaching behavior of 11 teachers in our sample who taught both a Type I class and a Type II or III class. Four of these 11 teachers were observed in Type I and Type II classes, and seven were observed in Type II and Type III classes. These individual teacher's classroom processes were investigated to determine if differences existed between the teaching processes for the same teacher in different types of math classrooms.

Type I Versus Type II Classes

An analysis of the teachers' profiles indicated that all four of the teachers who taught both Type I and Type II classes tended to assign more written work to the students in their Type I classes. Three of these teachers spent more class time not interacting with their Type I students. While all of the teachers spent more time with their Type II students in questioning and feedback activities, more interactions regarding mathematics were observed in the Type II classes for all four teachers.

These data seem to indicate that the same teacher will structure his or her class differently for different levels of math classes. In the Type I classes students work alone doing written assignments more and the teacher devotes more class time to classroom management activities (such as correcting papers and organizing materials). Because of this type of classroom structure the same teacher shows less interactive

instruction with general math students than with algebra I or geometry students. Time spent in instructing is the same for both levels of classes. The main difference seems to be that while students' time is spent in independent written assignments in the general math classes, in the algebra I and geometry classes the same teacher will provide for more class discussion time. This activity involves questioning, feedback, and reviewing homework assignments.

Type II Versus Type III Classes

For the seven teachers who taught both Type II and Type III classes, no clear differences were found in the methods used in these classes. Teachers varied on whether an observed teaching process occurred more in the Type II or Type III classes. Five of the seven teachers in the group interacted more with the entire class when instructing their Type III classes. In the Type II classes, the teachers tended to interact more with groups or individuals. Five of these teachers were also observed conducting more class discussion in their Type III classes. This might indicate a trend for teachers to conduct more interactive discussions with students in their higher level classes and to involve the entire class in the discussion.

Discussion

These data reveal findings similar to the analysis involving all classrooms in the study. Clear distinctions can be found in the teaching processes for the same teacher in the Type I and Type II classes; however, less difference is shown in the manner in which the same teacher will conduct a Type II and Type III class. The same teacher will tend to interact less with students in the Type I classes than those in Type II classes. Type I students are assigned more independent desk work while the teacher uses class time to correct students' work or organize materials. Nine of the 11 teachers led more class discussion in their higher level class.

The implications of this finding is that students in general math classes may not receive the teacher attention and instruction required to achieve well and continue in math studies.

VI IMPLICATIONS AND RECOMMENDATIONS

Our findings indicate that the most important factors influencing women's decisions to enroll in advanced math classes are parents' encouragement and support, students' successful experiences in math classes, spatial ability in math aptitude, and career plans.

These data suggest that parents should be informed of the importance of their influence upon students' decisions to take advanced mathematics. This finding is somewhat surprising in that secondary students tend to try to establish their own values and life styles and many verbally reject parental influence. Nonetheless, at some crucial level parents do affect student decisions through their support and recognition that math studies are important to mental development and as an entrance to some careers.

Students' spatial ability is related to math achievement. Women students with higher spatial ability and math achievement tended to be the ones who continued in math studies. The students who said they are good at mathematics are the same ones who tended to score high on the space relationships and math achievement tests. This was similar for men and women, although men scored slightly higher than women on the space relationships test.

Teachers were found to interact more often with men students than with women students. However, this fact did not seem to influence women's decisions regarding enrollment in advanced mathematics. The classroom processes that did relate to re-enrollment concerned an active instruction involvement of teachers with students whether they were men or women. The continuation of math studies was lowest in classrooms where more disciplining occurred and where there were more written assignments and less instruction. This suggests that teachers should be actively involved with students, providing instruction, questions, and feedback.

The study findings also suggest that the counseling programs and career education programs offered at these 11 schools have very little

influence on women's decisions to enroll in advanced math classes. Since the women taking geometry in this study appear to have already formulated their career plans, it seems that junior high schools as well as high schools should provide career education programs that expose young women to a wide range of career option experiences. Women may too quickly choose sex stereotyped careers if such exposure does not occur.

In one school, where women and men students are given many opportunities to see what it means to be a physicist, architect, or engineer through a math, engineering, and science association; a high percentage of women are enrolled in advanced math classes. This is the only functioning school program that appears to have an effect on student enrollment in advanced mathematics. This small urban school has a greater percentage of men and women students enrolled in advanced mathematics than to the other 10 high schools in this sample.

In conclusion, this study provides evidence that enrollment in advanced math classes is related to certain student abilities. While parents can be encouraged to support their children to take advanced mathematics and school career education programs can expose young women to a wider range of career choices, spatial ability may be sex-linked and not so amenable to change. However, the differences in the test scores of men and women were slight and the important idea here is to make able women and men students aware of their own potential and more aware of the career doors that are open to those who achieve in advanced mathematics.

VII DISSEMINATION

In the spring of 1979 we went to each of the 11 participating schools and described the findings of the study to all interested school personnel, administrators, teachers, and counselors. One school superintendent suggested developing some inservice workshops to share the information with other teachers and with parents.

In our recruitment of teachers we had agreed to provide each participating teacher with a personal profile of his or her own observed behaviors when the study was completed. In compliance with this agreement, the teachers who had taken part in the study were given a feedback package including their personal classroom profile of behavior. The feedback package included the following:

- Distribution of Teachers and Classes by School and Subject.
- Enrollment of Women Students in Math Classes.
- Test Scores for Their Own School and for Total Sample by Men and Women.
- Overview of the SRI Secondary Observation Instrument.
- Five Minute Interaction Variables by Type, Total Sample.
- Individual Teacher Profile - Snapshot.
- Individual Teacher Profile - Five Minute Interaction.
- Individual Teacher Profile - Class test scores and instructor ratings by men and women.
- Overall Student Ratings of Instructors.

Figures 2 and 3 are examples of the profiles that were given to the teachers. The first column of figures on the right hand side presents the means for all classrooms for Type II classes. The second column presents the teacher's own mean for each variable. These feedback sessions were well attended and teachers were interested in comparing their profile means with the means of other teachers in their type of class.

1 STUDENTS INVOLVED

TEACHER NAME:
TEACHER NUMBER:
HIGH SCHOOL
COURSE: GEOMETRY
STUDENT COUNT: MALES 14 FEMALES 10

STANDARD DEVIATIONS FROM THE MEAN				ALL	YOUR
-----LESS FREQ.-----M-----MORE FREQ.-----				CLASSES	CLASS
< 2111111111 1000000000 0 0000000001 1111111112 >					
< >					
< 0907654321 0907654321 0 1234567890 1234567890 >					
81	TEACHER CLASS MANAGE/NO STUDENTS: PROPORTION OF TIME			20.360	20.000
82	TOTAL SILENT READING	X		00.010	00.000
83	TOTAL READING ALGUD			00.000	00.000
84	TOTAL MAKING ASSIGNMENTS			01.039	06.984
85	TOTAL INSTRUCTION		X	25.353	28.253
86	TOTAL DISCUSSION		X	20.800	22.857
87	TOTAL PRACTICE DRILL			00.000	00.000
88	TOTAL WRITTEN ASSIGNMENTS		X	14.807	14.920
89	TOTAL TEST TAKING	X		02.147	00.000
90	TOTAL NON-MATH OR READING INSTRUCTION	X		00.405	00.000
91	TOTAL SOCIAL INTERACTION		X	12.672	14.920
92	TOTAL STUDENT UNINVOLVED	X		06.252	01.587
93	TOTAL DISCIPLINE		X	00.200	00.000
94	TOTAL CLASSROOM MANAGEMENT			01.014	04.124

TEACHER ACTIVITY BY GROUP - COUNTS FOR YOUR CLASS

1	8	2	6+2	5
SINGLE	SMALL	LARGE	SMALL+LARGE	EVERYONE
0	1	7	8	3

Figure 2 SAMPLE TEACHER PROFILE: SNAPSHOT - TYPE II CLASSROOM

TEACHER NAME;
TEACHER NUMBER
HIGH SCHOOL
COURSE: GEOMETRY
STUDENT COUNT: MALES 14 FEMALES 10

		STANDARD DEVIATIONS FROM THE MEAN		ALL	YOUR
		-----LESS FREQ.-----M+++++MORE FREQ.+++++		CLASSES	CLASS
		< 2111111111 1000000000 0 0000000001 1111111112 >			
		<>			
		< 0987654321 0987654321 0 1234567890 1234567890 >			
VARIABLES					
F10	ALL INTERACTION/FEMALE STUDENT-ADULT/VERBAL/MATH			38.685	30.666
F11	ALL INTERACTION/MALE STUDENT-ADULT/VERBAL/MATH	X		46.883	21.000
F15	FEMALE STUDENT COMMANDS, REQUESTS, DIR. QUEST./MATH		X	05.604	05.333
F16	MALE STUDENT COMMANDS, REQUESTS, DIR. QUEST./MATH		X	06.586	02.333
F18	ADULT COMMANDS, REQUESTS, DIR. QUEST./FEMALE STUDENT/MATH		X	03.721	03.000
F19	ADULT COMMANDS, REQUESTS, DIR. QUEST./MALE STUDENT/MATH		X	04.604	02.666
F20	ADULT-FEMALE STUDENT/CLARIFY QUEST./MATH	X		00.369	00.000
F29	ADULT-MALE STUDENT/CLARIFY QUEST./MATH	X		00.504	00.000
F34	FEMALE VOLUNTEER RESPONSES TO ADULT/MATH		X	01.225	01.333
F35	MALE VOLUNTEER RESPONSES TO ADULT/MATH		X	01.667	01.666
F40	ADULT RESPONSE/FEMALE STUDENT QUEST./MATH		X	05.486	03.666
F41	ADULT RESPONSE/MALE STUDENT QUEST./MATH	X		06.324	02.000
F43	ADULT INSTRUCT/FEMALE STUDENT/MATH	X		05.477	02.000
F44	ADULT INSTRUCT/MALE STUDENT/MATH	X		06.559	01.333
F54	ADULT SOCIAL INTERACTION/FEMALE STUDENTS	X		00.973	00.000
F55	ADULT SOCIAL INTERACTION/MALE STUDENTS	X		01.414	00.000
F57	ALL INTERACTION WITH OUTSIDE INTRUDER		X	01.558	00.000
F58	TEACHER IN CLASSROOM MANAGEMENT/NO STUDENTS		X	20.216	16.666
F62	ADULT ACKNOWLEDGE FEMALE STUDENTS/MATH		X	02.873	04.666
F63	ADULT ACKNOWLEDGE MALE STUDENTS/MATH		X	03.585	04.000
F65	ADULT PRAISE FEMALE STUDENT/MATH	X		00.261	00.000
F66	ADULT PRAISE MALE STUDENT/MATH	X		00.342	00.000
F74	FEMALE STUDENT NOT RESPONDING TO ADULT/MATH		X	00.234	00.333
F75	MALE STUDENT NOT RESPONDING TO ADULT/MATH	X		00.225	00.000
F80	ADULT ENCOURAGING FEMALE STUDENT/MATH		X	00.225	00.333
F81	ADULT ENCOURAGING MALE STUDENT/MATH	X		00.261	00.000
F83	ADULT MONITORING STUDENTS		X	10.792	10.333
F84	ADULT MOVEMENT		X	11.378	13.000
F85	ALL CLASSROOM INTERACTIONS/MATH		X	237.090	259.333
F87	ALL CLASSROOM INTERACTIONS/BEHAVIOR		X	03.918	06.000
F88	INTERACTION ADULT-FEMALE STUDENT/RELEVANCE OF MATH			00.000	00.000
F89	INTERACTION ADULT-MALE STUDENT/RELEVANCE OF MATH		X	00.072	00.000
F100	ALL CORRECTIVE FEEDBACK/FEMALE STUDENTS/MATH		X	08.027	11.000
F101	ALL CORRECTIVE FEEDBACK/MALE STUDENTS/MATH	X		10.126	03.333
F102	ADULT POSITIVE INTERACTION WITH FEMALE STUDENTS		X	00.414	00.333
F105	ADULT POSITIVE INTERACTION WITH MALE STUDENTS	X		00.396	00.000
F111	ADULT NEGATIVE INTERACTION WITH FEMALE STUDENT		X	00.063	00.000
F112	ADULT NEGATIVE INTERACTION WITH MALE STUDENT		X	00.135	00.333
F132	FEM. STONT NOT KNOW ANS./ADULT ASKS OTHER STONT/MATH	X		00.108	00.000
F133	MALE STONT NOT KNOW ANS./ADULT ASKS OTHER STONT/MATH		X	00.090	00.333
F134	FEMALE STONT ASKS QUEST./ADULT RESP. WITH QUEST./MATH		X	00.171	00.333
F135	MALE STONT ASKS QUEST./ADULT RESP. WITH QUEST./MATH	X		00.198	00.000

Figure 3 TEACHER PROFILE: FIVE MINUTE INTERACTION - TYPE II CLASSROOM

4

Fifteen of the teachers were observed in two different classes. It was of considerable interest to the teachers to see how they varied from one class situation to another. This analysis indicated that teachers who taught Type I classes were less interactive with those students and tended to assign work to be done in class. These same teachers teaching Type II classes provided more interactive instruction, e.g., they went over homework, reviewed tests, presented new information, questioned and provided feedback. The teachers found that this type of information helped them to become aware of their own behavior.

The study findings will be disseminated through the executive summary to all of those requesting information.

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Appendix A

INSTRUMENTS

INSTRUMENTS

NIE WOMEN AND MATH STUDY
Telephone Survey Data - School Report

School: _____ Phone: _____

District: _____ City: _____

Principal: _____ Phone: _____

Contact: _____ Phone: _____

Title: _____

1. What is the fall school enrollment? _____
 a) What is the approximate percentage of women in the school? _____
2. What levels of math courses are offered at the school?
 (Enter below)
3. How many classes or sections are there at each of these levels?
 (Enter below)
4. What is the percentage of women enrolled at each level?
 (Enter below)

Math Course Title	No. of Sections	Percentage Women	(Optional) Count	
			Female	Male

5. Is there a math club at the school, or any other math-oriented club (such as a computer science or chess club)?

IF NO, skip to Question 6

Math Club Yes No
☐ ☐

(Other) _____

(Other) _____

(Other) _____

(Other) _____

- a) How do students learn about these clubs?

- b) Approximately how many students participate in each of these clubs?

Math Club _____

(Other) _____

(Other) _____

- c) How often do they meet, or how often do students participate in activities?

Daily _____

Weekly _____

Monthly _____

(Other) _____

6. Is there a career education program at the school?

Yes No
☐ ☐

IF NO, skip to Question 7

- a) Where does the funding for this program come from?

Regular School Budget

☐

Special District Prgm funds

☐

Special State Prgm funds

☐

Special Federal Prgm funds

☐

- b) Is the "program" a formal course or a series of school activities?

Course

☐

Activities

☐

- 1) What kinds of activities?

- c) Approximately how many students participate at least once in the program during the school year?

- d) How often do students participate in program activities? For example, how many participate daily?

Daily 2-3 times per week Weekly Monthly Less than 3 times per year

e) Is there a Career Education Center at the school?

Yes	No
☐	☐

IF NO, skip to Question 7

1) Is the Center operated on a drop-in basis?

Yes	No
☐	☐

2) Is the Career Education Center also the Guidance Center?

Yes	No
☐	☐

7. Is there any other program at the school that is designed to increase participation in math classes or to increase students' awareness of the math needed for different careers?

Yes	No
☐	☐

IF NO, end interview

a) Where does the funding for this program come from?

Regular
School
Budget

☐

Special
District
Prgr funds

☐

Special
State
Prgr funds

☐

Special
Federal
Prgr funds

☐

b) Is the program a formal course or a series of school activities or both?

Course

☐

Activities

☐

1) What kinds of activities?

c) Approximately how many students participate at least once in the program during the school year?

d) How often do students participate in program activities? For example, how many participate daily?

Daily	2-3 times per week	Weekly	Monthly	Less than 3 times per year
_____	_____	_____	_____	_____

8. Note additional comments on reverse.

9. (To be asked at the district level.) What is the percentage of low income students at the school? (This typically will be percentage AFDC.)

**A STUDY OF FACTORS INFLUENCING WOMEN'S DECISIONS
TO ENROLL IN ELECTIVE MATHEMATICS CLASSES**

TEACHER QUESTIONNAIRE

SPRING 1978

NOTE: In this questionnaire the term "advanced mathematics" refers to any course taken after geometry.

Please enter your Name _____
(Last Name) (First Name) (Middle initial)

School: _____

Sex: Male _____ Female _____

Age: 20-35 _____

36-50 _____

51-65 _____

1. What math courses do you presently teach? (please list)

2. What other courses have you taught besides math? (please list)

3. How many years have you spent as a teacher?

No. years

4. How many years as a teacher in this school?

No. years

5. What is the highest degree you hold? (check one)

B.S./B.A. ☐

B.S./B.A. and 30 credits . . . ☐

M.S./M.A. ☐

M.S./M.A. and 30 credits . . ☐

Ph.D./Ed.D. ☐

6. What teacher certificate(s) do you hold? (please list)

7. About how many of your students sought your advice this year about whether or not they should take courses in advanced mathematics? (Since we are interested in whether men or women seek such advice with the same frequency, please answer for each sex.)

Approximate number of men seeking advice on math . . ☐

Approximate number of women seeking advice on math . ☐

8. How often would you say you have initiated contact with students this year about whether or not they should take courses in advanced math? (Again, please differentiate between men and women.)

Number of contacts I initiated with men
concerning courses in math ☐

Number of contacts I initiated with
women concerning courses in math ☐

9. This school year how many parents would you say have talked with you (either by telephone or in a meeting) to discuss their child's progress in math?

Number of parents of male students ☐

Number of parents of female students ☐

10. Of those discussions approximately what percentage were initiated by the parent?

Percentage initiated by male student's parent ☐

Percentage initiated by female student's parent ☐

11. How is the final decision made whether or not a given student is qualified to take a math course of a higher level than the one which he/she is currently enrolled?

1. Decided solely on basis of whether the student is receiving a passing grade in current math course ☐

2. Counselor decides based on what he/she knows about student ☐

3. Math teacher decides based on student's performance in math class ☐

4. Student decides based on his/her assessment of capabilities ☐

5. Teacher and counselor together decide ☐

6. Other (describe below) ☐

12. When you advise students about whether or not to take advanced math courses, what information do you feel is the most important to review in giving them that advice. Please enter the weight you assign to each item using the following scale:

5 = extremely important
4 = very important
3 = important
2 = somewhat important
1 = not important

Please assign these weights separately for men and women.

	<u>Men</u>	<u>Women</u>
<u>1 Standardized Achievement test scores</u>		
<u>2 Your experience with student</u>		
<u>3 Comments from teachers other than math teacher</u>		
<u>4 Grade point average</u>		
<u>5 Grades in previous math/science courses</u>		
<u>6 Student's I.Q.</u>		
<u>7 What you know of student's career plan</u>		
<u>8 What you know of student's college plans</u>		
<u>9 Comments from counselor</u>		
<u>10 Other (identify)</u>		

13. Which of the following come closest to your viewpoint? (check all that apply)

- 1 Spatial ability is related to math ability ☐
- 2 Men have better spatial ability than women ☐
- 3 Women are usually better math students than men . . . ☐
- 4 Men are usually better math students than women . . . ☐
- 5 Men and women are equally good in math ☐

14. Within your school, are men or women more likely to enroll in advanced math classes, or are they equally likely?

Men ☐

Women. ☐

Equally likely to enroll ☐

15. For each of the following statements please indicate whether you strongly agree, agree, disagree, or strongly disagree:

	Strongly agree	Agree	Disagree	Strongly disagree
1 More men than women should take advanced math since men will need it more later on				
2 Regardless of career plans anyone with the interest should take advanced math				
3 One of the most important reasons for taking advanced math has to do with future career choice				
4 It is as important to take advanced math for aesthetic values as it is for career purposes				
5 Not taking advanced math courses in high school decreases the likelihood of taking math in college				

16. Many factors influence a student's decision to take no more than the math required for high school graduation. Please indicate how strongly the factors listed below influence a student not to take math. Use the following scale:

5 = extremely important

4 = very important

3 = important

2 = somewhat important

1 = not important

Since we are interested in affects on men and women, please weight these separately.

	<u>Men</u>	<u>Women</u>
<u>1 Student's parents/family</u>		
<u>2 Student's capability</u>		
<u>3 Friends</u>		
<u>4 Math teachers</u>		
<u>5 Other teachers</u>		
<u>6 Counselor</u>		
<u>7 Student's college plans</u>		
<u>8 Student's career plans</u>		
<u>9 Other (describe) _____</u>		

17. Now consider the factors that influence a student's decision to take advanced math courses. Use the same scale.

5 = extremely important

4 = very important

3 = important

2 = somewhat important

1 = not important

	<u>Men</u>	<u>Women</u>
<u>1 Student's parents/family</u>		
<u>2 Student's capability</u>		
<u>3 Friends</u>		
<u>4 Math teachers</u>		
<u>5 Other teachers</u>		
<u>6 Counselor</u>		
<u>7 Student's college plans</u>		
<u>8 Student's career plans</u>		
<u>9 Other (describe) _____</u>		

18. Please estimate the percentage of students at this school who take:

Percent of Students

One year of math . . . _____

Two years of math . . . _____

Three years of math. . . _____

Four years of math . . . _____

19. In your opinion how many years of math should students be required to take?

No. years

20. What is the approximate percentage of men and women in each of the math courses you teach? (Please give us your estimate not a real count.)

	Percent Men	Percent Women
<u>General Math</u>		
<u>Introductory Algebra</u>		
<u>Algebra I</u>		
<u>Math I Honors Algebra</u>		
<u>Geometry</u>		
<u>Math II Honors Geometry</u>		
<u>Algebra II</u>		
<u>Trig/Math Analysis</u>		
<u>Calculus</u>		
<u>Other (identify)</u>		

21. Which of the clubs and activities listed below exist in your school, and in which do you participate or direct? (Check as many as apply)

	Exists in <u>School</u>	I participate/ <u>direct</u>
1 <u>Career Education Program</u>		
2 <u>Career Clubs</u>		
3 <u>Math Club</u>		
4 <u>Chess Club</u>		
5 Other math-related club (describe) _____		
6 <u>Career Assembly</u>		

22. Are there any subjects other than math which you would also like to teach?

Yes ☐
 No ☐

1 (IF YES) What subjects are these? (please list)

23. Are there math courses, other than the one you currently teach, which you would like to teach?

Yes ☐
 No ☐

1 (IF YES) What courses are these? (please list)

24. Which of the following statements is most true about you? (check one)

1 I enjoy teaching and will do so for the foreseeable future ☐

2 I like teaching but would prefer to move into an administrative position ☐

3 I liked teaching at first but am frustrated now by the teaching load and extra duties ☐

4 I plan to leave teaching as soon as a better position comes along. ☐

25. What do you think is the single most important reason for women traditionally not taking more math?

26. We are trying to find out what math teachers think about whether men or women are better math students, and why students take advanced math courses. Please share with us any additional feelings you may have.

A STUDY OF FACTORS INFLUENCING WOMEN'S DECISIONS
TO ENROLL IN ELECTIVE MATHEMATICS CLASSES

COUNSELOR QUESTIONNAIRE

SPRING 1978

NOTE: FOR THIS QUESTIONNAIRE THE TERM "ADVANCED MATHEMATICS" REFERS TO ANY MATH COURSES TAKEN AFTER GEOMETRY.

Please enter your Name _____
(Last Name) (First Name) (Middle initial)

School: _____

Sex: Male _____ Female _____

Age: 20-35 _____

36-50 _____

51-65 _____

1. How many years have you spent as a counselor?

No. years

2. How many years as a counselor in this school?

No. years

3. What is the highest degree you hold? (check one)

B.S./B.A. ☐

B.S./B.A. and 30 credits . . . ☐

M.S./M.A. ☐

M.S./M.A. and 30 credits . . . ☐

Ph.D./Ed.D. ☐

4. In what area is your highest degree? (please write in)

Area of degree

5. What professional certificate(s) do you hold? (please list)

6. Have you ever been a math teacher?

Yes ☐

No. ☐ skip to Q. 7

6.1 (IF YES) What math courses did you teach? (please list)

6.2 Are you presently teaching math?

Yes ☐

No. ☐

7. How many students do you have in your caseload?

No. students

8. Which of the following statements most accurately describes the composition of your caseload? (check one)

I have the same students throughout
their tenure in the school. ☐

My caseload changes every year ☐

9. What percentage of your caseload do you see

Enter Percent
of Caseload

Once or twice a year.

Three to eight times a year

More than once a month

100%

10. For each of the following areas do you think you affect student decisions a great deal, some, or not at all?

	Affect a great deal	Affect Some	Don't affect at all
1. Whether or not to take math courses			
2. In career decisions			
3. In making college plans			

11. For what percentage of the time you meet with students do you, students, teachers, parents, or others initiate the contact?

	Enter Percent of time
I initiate contact	_____
Students initiate contact . . .	_____
Teachers initiate contact . . .	_____
Parents initiate contact	_____
Other (please identify)	
initiated contact	_____
	100%

12. Listed below are some of the areas about which students may meet with you. For each of the items please show whether this is frequently, sometimes, or never, using the following scale:

3 = frequently
2 = sometimes
1 = never

Since we are interested in whether men or women students meet with you for the same reasons, please enter values for each sex separately.

	<u>Men</u>	<u>Women</u>
1. Poor academic performance		
2. Problems with parents		
3. Problems with friends		
4. Advice about college selection		
5. Advice about course selection		
6. Advice on personal problem(s)		
7. Problems with a specific class		
8. Discipline problem(s)		
9. Other (describe) _____		

13. How is the final decision made whether or not a given student is qualified to take a math course of a higher level than the one in which he/she is currently enrolled. (check one)

1. Decided solely on basis of whether the student is receiving a passing grade in current math course . . . ☐
2. Counselor decides based on what he/she knows about student ☐
3. Math teacher decides based on student's performance in math class ☐
4. Student decides based on his/her assessment of capabilities ☐
5. Teacher and counselor decide ☐
6. Other (describe) _____ ☐

14. When you advise students about whether or not to take science or advanced math courses, what information do you feel is the most important to review in giving them that advice. Please enter the weight you assign to each item using the following scale:

5 = extremely important
4 = very important
3 = important
2 = somewhat important
1 = not important

Please assign these weights separately for men and women.

	<u>Men</u>	<u>Women</u>
1. Standardized Achievement test scores		
2. Comments from math teacher		
3. Comments from teachers other than math teacher		
4. Grade point average		
5. Grades in previous math/science courses		
6. Student's I.Q.		
7. What you know of student's career plan		
8. What you know of student's college plans		
9. What you know of student's interest based on previous contacts		
10. Other (identify) _____		

15. Which of the following come closest to your viewpoint? (check as many as you agree with)

1. Spatial ability is related to math ability ☐
2. Men have better spatial ability than women ☐
3. Women are usually better math students than men . . . ☐
4. Men are usually better math students than women . . . ☐
5. Men and women are equally good in math ☐

16. Within your school, are men or women more likely to enroll in advanced math classes, or are they equally likely?

Men ☐

Women. ☐

Equally likely to enroll ☐

17. For each of the following statements please indicate whether you strongly agree, agree, disagree, or strongly disagree:

	<u>Strongly agree</u>	<u>Agree</u>	<u>Disagree</u>	<u>Strongly disagree</u>
1. More men than women should take advanced math since men will need it more later on				
2. Regardless of career plans anyone with the interest should take advanced math				
3. An important reason for taking advanced math has to do with future career choice				
4. It is as important to take advanced math for aesthetic values as it is for career purposes				

18. Many factors influence a student's decision to take no more than the math required for high school graduation. Please indicate how strongly the factors listed below influence a student not to take math. Use the following scale:

5 = extremely important
 4 = very important
 3 = important
 2 = somewhat important
 1 = not important

Since we are interested in affects on men and women, please weight these separately.

	<u>Men</u>	<u>Women</u>
1. Student's parents/family		
2. Student's capability		
3. Friends		
4. Math teachers		
5. Other teachers		
6. Counselor		
7. Student's college plans		
8. Student's career plans		
9. Other (describe) _____		

19. Now consider the factors that influence a student's decision to take advanced math courses. Use the same scale.

5 = extremely important
 4 = very important
 3 = important
 2 = somewhat important
 1 = not important

	<u>Men</u>	<u>Women</u>
1. Student's parents/family		
2. Student's capability		
3. Friends		
4. Math teachers		
5. Other teachers		
6. Counselor		
7. Student's college plans		
8. Student's career plans		
9. Other (describe) _____		

20. Please estimate the percentage of students at this school who take:

Percent of Students

One year of math . . . _____
 Two years of math . . . _____
 Three years of math. . . _____
 Four years of math . . . _____

21. In your opinion how many years of math should students be required to take?

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No. years

22. What do you think is the single most important reason for women not traditionally taking more math?

23. We are trying to find out what counselors think about whether men or women are better math students, and why students take advanced math courses. Please share with us any additional feelings you have not already covered by the foregoing questions.

**A STUDY OF FACTORS INFLUENCING STUDENT'S DECISIONS
TO ENROLL IN ELECTIVE MATHEMATICS CLASSES**

STUDENT QUESTIONNAIRE

SPRING 1978

Please enter your Name: _____
 (Last name) (First name) (Middle
 Initial)

School: _____

Grade: _____

Sex: Male _____ Female: _____

1. How many years have you been in this high school? (Include the present year; if you entered school in mid-year show a $\frac{1}{2}$ year.)



Number of Years

2. Listed below are the mathematics courses generally offered in high school. Please indicate by a check mark (✓) whether you took the course in high school before this school year; are enrolled now; plan to take it next year.

Math Course Title	Took before this year	Am enrolled now	Plan to take next year
General Math			
Algebra I			
Geometry			
Honors Geometry			
Algebra II			
Trig/Math Analysis			
Math II Honors (Geometry & Algebra)			
Math III Honors (Algebra II & Trig)			
Calculus			

3. Below are reasons you are, or are not, taking math next year in high school or college. Please show with a (✓) in the columns provided whether these reasons are very important, important, or not important.

ANSWER IF YOU ARE TAKING MATH
NEXT YEAR



3.1 I am taking math next year
because:

	Very impor- tant	Impor- tant	Not Impor- tant
1. I'm good at it . . .			
2. I was put in an advanced math class			
3. I like math . . .			
4. It's a requirement to enter college			
5. It is important for my career. .			
6. My friends are taking it. . . .			
7. My parents/family think I should .			
8. I like the teacher			
9. My counselor advised me to...			
10. My teacher suggested it . .			
11. I get good grades in math.			

12. Other (describe below)

ANSWER IF YOU ARE NOT TAKING
MATH NEXT YEAR



3.2 I am not taking math next year
because:

	Very impor- tant	Impor- tant	Not Impor- tant
1. I don't like it . . .			
2. I am not in an advanced math lane.			
3. I'm not good at it.			
4. It's not important for college . . .			
5. It's not important for my career . .			
6. None of my friends are taking it . .			
7. My parents/family don't think it's necessary			
8. My teacher advised me not to			
9. My counselor advised me not to			
10. I don't like the teacher(s). . . .			
11. I've taken all I need to graduate from high school.			
12. I might get a bad grade			

13. Other (describe below)

4. Think about math classes you have had so far in high school. For each class indicate your feelings about the teacher who taught the class. If the teacher was a man put your check in the M side of the column you choose; if the teacher was a woman, put your check in the F side of the column. (Do not make an entry for the course you are in now.)

	Like (L) the teacher very much		Like (L) the teacher		Dislike (D) the teacher		Dislike (D) the teacher very much	
	M	F	M	F	M	F	M	F
<u>General Math</u>								
<u>Algebra I</u>								
<u>Geometry</u>								
<u>Honors Geometry</u>								
<u>Algebra II</u>								
<u>Trig/Math Analysis</u>								
Math II Honors (Geometry & Algebra)								
Math III Honors (Algebra II & Trig)								
<u>Calculus</u>								

5. Now tell us how you liked the course work for those classes you have checked above. Did you like the course very much, like it, dislike it, or dislike it very much?

	Like (d) the Course very much	Like (d) the Course	Dislike (d) the Course	Dislike (d) the course very much
<u>General Math</u>				
<u>Algebra I</u>				
<u>Geometry</u>				
<u>Honors Geometry</u>				
<u>Algebra II</u>				
<u>Trig./Math Analysis</u>				
<u>Math II Honors (Geometry & Algebra)</u>				
<u>Math III Honors (Algebra II & Trig.)</u>				
<u>Calculus</u>				

6. How difficult did you find the courses? Were they very difficult, quite difficult, or did you have little or no difficulty with them?

	I found it very difficult	I found it quite difficult	I had little or no difficulty
<u>General Math</u>			
<u>Algebra I</u>			
<u>Geometry</u>			
<u>Honors Geometry</u>			
<u>Algebra II</u>			
<u>Trig./Math Analysis</u>			
<u>Math II Honors (Geometry & Algebra)</u>			
<u>Math III Honors (Algebra II & Trig.)</u>			
<u>Calculus</u>			

7. Would you take a math class from a teacher you did not like? (check one)

Yes ☐

No ☐

8. In math classes you have taken up to, and including, this year, did teachers favor male or female students, or did they treat them equally? If the teacher was a man, make your check in the column headed Male Teacher. If the teacher was a woman, make your check in the column headed Female Teacher.

	Teacher favored male students		Teacher favored female students		Treated all equally	
	Male Teacher	Female Teacher	Male Teacher	Female Teacher	Male Teacher	Female Teacher
<u>General Math</u>						
<u>Algebra I</u>						
<u>Geometry</u>						
<u>Honors Geometry</u>						
<u>Algebra II</u>						
<u>Trig./Math Analysis</u>						
<u>Math II Honors (Geometry&Algebra)</u>						
<u>Math III Honors (Algebra II&Trig.)</u>						
<u>Calculus</u>						

9. In your opinion, what characteristics describe a math teacher you like and a math teacher you dislike. Check (✓) as many as you wish. Please put two checks (✓✓) next to any item you feel applies most strongly to a math teacher you like or dislike.

	Teacher <u>I like</u>	Teacher <u>I dislike</u>
Explains lessons clearly		
Goes slowly		
Gives lots of examples		
Is young (under 35)		
Is fair		
Goes quickly		
Gives extra work to students who need or want it		
Is entertaining		
Treats students like adults		
Has high expectations of students		
Is warm and friendly		
Gives lots of homework		
Is well prepared		
Is concerned with covering everything in the text		
Asks lots of questions		
Gives little or no homework		
Gives lots of tests		
Is not young (over 35)		
Gives a second chance to pass a test		
Encourages students to work individually		
Encourages students to work in groups		
Gives extra help to students who need or want it		

10. Do you prefer a male or a female math teacher, or do you have no preference?

Male ☐

Female ☐

No preference . . . ☐

11. This past year how often have you talked with your math teacher, just the two of you, to discuss your work, future plans, or career? (If none, enter "0".)

At your request ☐
No. of times

At your math teacher's request . ☐
No. of times

12. This past year how often have you met with your counselor? (Count only those times you had an official appointment, not chance meetings. Enter "0" if you have not met this year and skip to Question 14.)

At your request ☐
No. of times

At your counselor's request . . ☐
No. of times

(ANSWER THIS QUESTION ONLY IF YOU HAVE MET WITH YOUR COUNSELOR THIS YEAR.)

13. In your discussion(s) with your counselor would you say he/she

Encouraged you to take math ☐

Discouraged you from taking math . . . ☐

We didn't talk about math ☐

The next set of questions refers to your father and/or your mother. If, instead of one of these there is someone else in your home who takes their place, and whom you think of as a father or mother, please use that person when answering these questions.

14. Thinking now of your family, please tell us what kind of full-time work people in your family do--your father, your mother, and any older brothers and older sisters. (Leave blank if not applicable. If you have more than three older brothers or sisters please list occupations in space provided.)

Father's occupation: _____

Mother's occupation: _____

Older brother's: _____

Older brother's: _____

Older brother's: _____

Older sister's: _____

Older sister's: _____

Older sister's: _____

15. Check below the highest level of school each family member has received so far. In the last column, write in the major, such as science, music, history, business, English, law, medicine, and so on. (List additional older brothers' or sisters' education in space provided.)

	Some high school	Finished high school	Some college	Finished college	Graduate work	Major
Father						
Mother						
Older brother						
Older brother						
Older brother						
Older sister						
Older sister						
Older sister						

16. The following statements refer to your mother's and father's feelings about math. For each statement check the appropriate columns for your mother and then your father. (For instance, if the statement is true of your mother, make a check in the 'yes' column under Mother; if the statement is not true of your Father, make the check in the 'no' column under father. If you don't know how they feel, or if the statement is not applicable, check the appropriate column.)

	Mother				Father			
	Yes	No	Don't Know	Not Applicable	Yes	No	Don't Know	Not Applicable
Thinks mathematics is one of the most important subjects I've studied.								
Likes mathematics.								
Says he/she is "no good" in math.								
Thinks mathematics is as important for females as for males.								
Thinks I'll need mathematics to get a good job.								
Expects me to do well in math.								
Wants me to take advanced math.								
Is interested in my progress in math.								

17. What is the highest level of education your parents expect you to complete? (Check only one.)

High school ☐
Vocational, trade or business school. ☐
A two-year or junior college ☐
A four-year college or university ☐
A graduate or professional school after college ☐
Don't know ☐

18. During this past school year how often have your parents or other family members talked to you about the importance of taking math? (Check only one.)

Several times . . . ☐
Once or twice . . . ☐
Never ☐

19. How often does someone in your home help you with your math homework? (Include these times they sit down with you as well as when they just answer a quick question)

Once a week or more . . . ☐
Once or twice a month . . . ☐
Two or three times this year . ☐
Never ☐

20. In your school which of the following apply to boys and girls who seem to be popular? (If any of these is more important than the others, please put a double check)

	Popular Boy	Popular Girl
Goes to a lot of social functions (football games, dances, etc.)		
He or she is a good athlete		
Is good looking		
Is outgoing		
Is a good student		
Dresses well		
Runs for student office		
Is a good organizer		
Other (describe) _____		

21. Thinking now of your friends, indicate with a check (✓) how important the following are in keeping your friendship going.

	Very Important	Important	Not Important
We have interests in common (e.g., sports, music, dance, clubs)			
All are good students			
Go to the same school			
Are together in some classes			
Have fun when we're together			
Can be honest with each other			
Trust each other			
Have similar college plans			
Other (describe) _____			

22. Is it important to you to have friends enrolled in the same math class as you?

Important, I would not enroll
if I have no friend(s) in class . . . ☐

Important, I would enroll anyway
but not enjoy it as much. ☐

Not important. ☐

23. This year, were any of your close friends enrolled in the same math class as you?

Yes ☐

No ☐

24. For each of the following items please indicate with a check whether you strongly agree, agree, disagree, or strongly disagree with the statement.

	Strongly Agree	Agree	Disagree	Strongly Disagree
How well I do in math is entirely up to me.				
My getting a good grade in math depends entirely on hard work.				
If I am having trouble doing math it is because the teacher didn't explain it clearly.				
A lot of students find math easier than I do.				
Having to do math makes me nervous.				
If I really wanted to, I could learn enough math to be a scientist, an engineer, or a math teacher.				
Sometimes I feel that I just can't learn math.				
I am afraid of math.				
Mathematics is an interesting subject.				

25. Which of the clubs and activities listed below exist in your school and in which do you participate? (Check also if you like the activity.)

	Exists	I attend	I like it
1. Career Education Program			
2. Career Club			
3. Math Club			
4. Chess Club			
5. Career Assembly			
6. Special math/science program			
7. M.E.S.A.			
8. Other math-related club (such as bridge club, astronomy club, etc.)			
List: 1.			
2.			
3.			

26. Have you participated in any other math related activities such as a special math or science program, fair, or seminar outside the school during this past year?

Yes..... ☐

No..... ☐

(IF YES) please describe _____

27. What are your plans for the next five years? (Check as many as apply.)

Education ☐

Travel and adventure ☐

Job ☐

Marriage . . . , ... ☐

Family ☐

Other (describe) ☐

28. What level of education do you plan to complete? (Check only one.)

High School ☐

A year or two of college ☐

A year or two of technical school . ☐

Bachelor's degree ☐

Some graduate work ☐

M.A. or equivalent ☐

Ph.D. ☐

Other (describe) _____

I am unsure of my plans ☐

29. What career are you interested in?

(enter career)

That's all. Please check over your questionnaire to make sure you have answered all the questions you can. Thank you again for helping us.

Student Interview Guide

(The interviewer has read the student responses on the questionnaire.
These responses guide the interview.)

1. (Check Q. 1 on Student Questionnaire to see how long student has been at this high school).
So you've been here at _____ High School for _____ years.
How do you like it by now?

What do you like best about the school?

What do you like least about the school?

2. (Check Q. 2 for math courses taken.)
I see that you've taken _____,
and _____.
Which of these was your favorite course? _____
Why?

What do you feel you've been learning in these math classes?

How does that compare in importance to what you are learning in other classes like English or History?

3. (Check Q. 3. If student hasn't checked "I like math," or "I don't like math," then ask:)

I see that you are taking/not taking another math course. How do you feel about math?

(If student has checked "I like math," or "I don't like math," eliminate above question.)

When did you start feeling that way?

What made you feel that way?

Of all the reasons you've checked, could you tell us which is the most important?

4. (Check Q. 4 for liked/disliked teachers.)
Could you tell us a little more about why you like/don't like teachers?

Are the math teachers as good as other teachers in the school?

5. (Check Q. 5 for liked/disliked coursework.)
Tell me some more about why you liked/disliked the math courses.

6. (Check Q. 5 for difficulty of courses.)
Have your math courses been easier or harder than other courses?

Why is that?

7. (Check Q. 4 for sex of math teacher.)
I see that you've had __ male and __ female math teachers.
(Check Q. 10 for preference.)
Could you tell me why you prefer a male/female math teacher?

8. (Check Q. 11 for talks with math teachers.)
I see you've met with your math teacher about ____ times this year.
What were the meetings about?

9. (Check Q. 12 and 13 for counselor relationship.)
I see you've met with your counselor about ____ times this year.
What were these meetings about?

or

I see you've not met with your counselor this year.
Are there any reasons why you haven't?

10. In any of the math classes you've had, have students studied together or helped each other with homework?
(if yes) Which ones?

Is there a reason why that's happened in those classes and not in others?

How about classes other than math?

11. (Check Q. 25 for extra activities attended.)
Have any of the extra activities you attended been fun and helpful?
Which ones?

Do you ever go to the Career Education Center?
What kind of information do you get from them?

12. Overall, how useful has your math been to you so far?

Why is that?

How useful do you think math will be to you in your future?

Why is that?

(Check Q. 29 for career of interest.)
In what ways do you think the math you've taken will be useful to
the career you're now interested in?

STUDENT RATING SCALE OF INSTRUCTORS

Scales used for analysis to describe students' perception of the instructors are as follows:

<u>Rating</u>	<u>Number of Items</u>	<u>Scale</u>	<u>Items</u>
Professional	8	1-40	1, 2, 3, 5, 6, 10, 13, 15
Individual/personalized	6	1-30	7, 8, 11, 12, 14, 16
Fair	1	1-5	4
Enjoys class	1	1-5	9

STUDENT RATING SCALE OF INSTRUCTORS

DIRECTIONS: Use the pencil provided. Select the rating number that best describes the person or course. Circle the numbered response on this questionnaire. Make no other marks on this form.

1	<u>Objectives and Goals of Course</u>	<u>1</u> Fails to explain the course objectives	<u>2</u> Somewhere between 1 & 3	<u>3</u> Makes class goals clear	<u>4</u> Somewhere between 3 & 5	<u>5</u> Is very clear in relating course work to objectives
2	<u>Clearness of assignments</u>	<u>1</u> Directions and assignments are unclear	<u>2</u> Somewhere between 1 & 3	<u>3</u> Directions and assignments are sometimes clear	<u>4</u> Somewhere between 3 & 5	<u>5</u> Directions and assignments are always clear
3	<u>Importance of assignments</u>	<u>1</u> Assignments are meaningless busy-work	<u>2</u> Somewhere between 1 & 3	<u>3</u> Assignments are sometimes necessary work	<u>4</u> Somewhere between 3 & 5	<u>5</u> Assignments are always necessary work
4	<u>Fairness of grading</u>	<u>1</u> Grading is unfair	<u>2</u> Somewhere between 1 & 3	<u>3</u> Sometimes fair in grading	<u>4</u> Somewhere between 3 & 5	<u>5</u> Grading is fair
5	<u>Classroom control in discipline</u>	<u>1</u> Lacks classroom control; seldom handles discipline well	<u>2</u> Somewhere between 1 & 3	<u>3</u> Has fair classroom control; sometimes handles discipline well	<u>4</u> Somewhere between 3 & 5	<u>5</u> Has good classroom control; always handles discipline well
6	<u>Preparation for class</u>	<u>1</u> Never is well prepared for class	<u>2</u> somewhere between 1 & 3	<u>3</u> Sometimes prepared for class	<u>4</u> Somewhere between 3 & 5	<u>5</u> Always is well prepared for class
7	<u>Manner of speaking with students</u>	<u>1</u> I find it hard to talk with this teacher	<u>2</u> Somewhere between 1 & 3	<u>3</u> I can sometimes talk with this teacher	<u>4</u> Somewhere between 3 & 5	<u>5</u> I find it easy to talk with this teacher
8	<u>Ability to Listen</u>	<u>1</u> Never listens to what I have to say	<u>2</u> Somewhere between 1 & 3	<u>3</u> Usually listens to what I have to say	<u>4</u> Somewhere between 3 & 5	<u>5</u> Carefully listens and responds to me
9	<u>Student Enjoyment of Class</u>	<u>1</u> Never enjoys the class	<u>2</u> Somewhere between 1 & 3	<u>3</u> Sometimes enjoys the class	<u>4</u> Somewhere between 3 & 5	<u>5</u> Always enjoys the class

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- | | | | | | | |
|----|--|--|-------------------------------------|--|-------------------------------------|---|
| 10 | <u>Benefit of course</u> | <u>1</u>
I have learned nothing from this course | <u>2</u>
Somewhere between 1 & 3 | <u>3</u>
I have learned an average amount in this course | <u>4</u>
Somewhere between 3 & 5 | <u>5</u>
I have learned a great deal in this course |
| 11 | <u>Effort to help students</u> | <u>1</u>
Teacher makes no effort to help me do well in this class | <u>2</u>
Somewhere between 1 & 3 | <u>3</u>
Teacher makes some effort to help me do well in this class | <u>4</u>
Somewhere between 3 & 5 | <u>5</u>
Teacher always makes an effort to help me do well in this class |
| 12 | <u>Interest in students</u> | <u>1</u>
Not interested in me as an individual | <u>2</u>
Somewhere between 1 & 3 | <u>3</u>
Somewhat interested in me as an individual | <u>4</u>
Somewhere between 3 & 5 | <u>5</u>
Interested in me as an individual |
| 13 | <u>Presentation of material</u> | <u>1</u>
Explains the lesson in a confusing manner | <u>2</u>
Somewhere between 1 & 3 | <u>3</u>
Explains the lesson clearly | <u>4</u>
Somewhere between 3 & 5 | <u>5</u>
Explains even difficult ideas well |
| 14 | <u>Participation</u> | <u>1</u>
Never encourages students to question or participate | <u>2</u>
Somewhere between 1 & 3 | <u>3</u>
Sometimes encourages students to question or participate | <u>4</u>
Somewhere between 3 & 5 | <u>5</u>
Always encourages students to question or participate |
| 15 | <u>Stimulation of thought</u> | <u>1</u>
Never encourages students to think | <u>2</u>
Somewhere between 1 & 3 | <u>3</u>
Sometimes encourages students to think | <u>4</u>
Somewhere between 3 & 5 | <u>5</u>
Always encourages students to think |
| 16 | <u>I have been able to get help from this teacher outside of class</u> | <u>1</u>
Yes | <u>2</u>
No | <u>3</u>
Have not tried to get help | | |
| 17 | <u>What is your sex?</u> | <u>1</u>
Female | <u>2</u>
Male | | | |
| 18 | <u>What is your ethnic origin</u> | <u>1</u>
Spanish surname | <u>2</u>
White | <u>3</u>
Black | <u>4</u>
Asian | <u>5</u>
Polynesian, Filipino
American Indian |
| 19 | <u>What is your present grade level?</u> | <u>1</u>
Six | <u>2</u>
Seven | <u>3</u>
Eight | | |
| | | <u>4</u>
Freshman | <u>5</u>
Sophomore | <u>6</u>
Junior | <u>7</u>
Senior | |
| 20 | <u>What is your birthdate?</u> | <u>month</u> | <u>day</u> | <u>year</u> | | |

SRI SECONDARY OBSERVATION INSTRUMENT
(Teacher-Focus)

OVERVIEW

The SRI teacher-focus Secondary Observation Instrument (SOI) provides a record of activities that occur in the classroom and the interactions between teachers and students, focusing on the teacher and those persons with whom he or she is interacting. The instrument was designed to be sensitive to different instructional methods, interpersonal interactions, and classroom environments. For the purpose of this study, the lead teacher in the classroom will be regarded as the focus person.

This observation instrument assesses the educational processes, which include teacher behaviors, interactions between teachers and male and female students, and the groupings of teachers and students that occur during classroom activities

The observation instrument contains three sections: Identification and Classroom Information, Classroom Snapshot, and Five-Minute Interactions. Classroom information is recorded in all of these sections, and each section will be described in detail in Section II of this manual, "Explanation of Coding Procedures."

The first section, Identification and Classroom Information, provides identification information necessary for data processing and analysis, and records the number of adults and students regularly in the classroom and the duration of the class.

The second section is the Classroom Snapshot. The Snapshot is a form that yields data about the nature of the activities of each adult and student in the classroom, the size of the groupings, and the materials being used. From this section, information is obtained on how the teacher spends his or her time and with whom, how the aides spend their time and

with whom, how often the students operate independently, and the activities that occur. Materials used are also recorded.

The third section is the Five-Minute Interaction (FMI). The Five-Minute Interaction can be used to observe teachers in group interactions or working alone. It consists of a series of frames in which each behavior/interaction is recorded in the four categories provided: who, to whom, what, and how. Several frames that follow each other record the entire interaction, or, for single individuals, describe the observable interaction.

At the beginning of each observation booklet there is one set of each of the Identification and Classroom Information section. Subsequent pages contain five sets of the Classroom Snapshot and Five-Minute Interaction frames. The Identification and Classroom Information section is coded only once during the class period; the Classroom Snapshot and the FMI are coded five times per booklet.



SECONDARY OBSERVATION INSTRUMENT

DIRECTIONS: Make sure that all of the identifying information has been entered on the Classroom Summary Information form prior to any observation. Do not make any stray marks outside the boxes provided in places where written information is required. Make sure you code the classroom summary information on form booklet Identification Number in the I.D. grid of all booklets used in the observation.

FOCUS PERSON NUMBER					
0	0	0	0	0	0
1	1	1	1	1	1
2	2	2	2	2	2
3	3	3	3	3	3
4	4	4	4	4	4
5	5	5	5	5	5
6	6	6	6	6	6
7	7	7	7	7	7
8	8	8	8	8	8
9	9	9	9	9	9

GRADE LEVEL	
From	To
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9

OBSERVER NUMBER			
0	0	0	0
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

OBS. NO.
0
1
2
3
4
5
6
7
8
9

DATE		
MO.	DAY	YR.
0	0	0
1	1	1
2	2	2
3	3	3
4	4	4
5	5	5
6	6	6
7	7	7
8	8	8
9	9	9

BOOKLET NUMBER			
0	0	0	0
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

SUBJECT IDENTIFIER	
READING	☐
MATH	☐
ENGLISH	☐
SOC. SCI.	☐
SCIENCE	☐
FINE ART	☐
CAREER ED.	☐
VOC. ED.	☐
OTHER	☐

A		B	
0	0	0	0
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

A. No. of
Male
students
enrolled

Teacher _____

B. No. of
Female
students
enrolled

School _____

City _____

Observer _____

- ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 Number of teachers that regularly work in the classroom
- ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 Number of aides that regularly work in the classroom
- ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 Number of volunteers present
- ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 Number of parents/visitors present

☐ Y ☐ N Group by ability within class

Total Class Duration

- | | |
|----------------------------------|-----------------------------------|
| ☐ 20 minutes | ☐ 55 minutes |
| ☐ 25 minutes | ☐ 60 minutes |
| ☐ 30 minutes | ☐ 70 minutes |
| ☐ 35 minutes | ☐ 80 minutes |
| ☐ 40 minutes | ☐ 90 minutes |
| ☐ 45 minutes | ☐ 100 minutes |
| ☐ 50 minutes | ☐ 110 minutes |
| | ☐ 120 minutes |

MATERIAL ACTIVITY

For this Snapshot Only

A-62.

Form Person I.D.				Act. Start	Time Started		Seq. No.
					Hrs.	Min.	
0	0	0	0		0	0	1
1	1	1	1		0	1	2
2	2	2	2		0	2	3
3	3	3	3		0	3	4
4	4	4	4		0	4	5
5	5	5	5		0	5	
6	6	6	6		0	6	
7	7	7	7		0	7	
8	8	8	8		0	8	
9	9	9	9		0	9	

FIVE MINUTE INTERACTION

9	Who	To Whom	What	How
0	T	A	V	T
1	F	M	S	F
2	L	E	S	L

10	Who	To Whom	What	How
0	T	A	V	T
1	F	M	S	F
2	L	E	S	L

11	Who	To Whom	What	How
0	T	A	V	T
1	F	M	S	F
2	L	E	S	L

12	Who	To Whom	What	How
0	T	A	V	T
1	F	M	S	F
2	L	E	S	L

13	Who	To Whom	What	How
0	T	A	V	T
1	F	M	S	F
2	L	E	S	L

14	Who	To Whom	What	How
0	T	A	V	T
1	F	M	S	F
2	L	E	S	L

15	Who	To Whom	What	How
0	T	A	V	T
1	F	M	S	F
2	L	E	S	L

16	Who	To Whom	What	How
0	T	A	V	T
1	F	M	S	F
2	L	E	S	L

17	Who	To Whom	What	How
0	T	A	V	T
1	F	M	S	F
2	L	E	S	L

18	Who	To Whom	What	How
0	T	A	V	T
1	F	M	S	F
2	L	E	S	L

1	Who	To Whom	What	How
0	T	A	V	T
1	F	M	S	F
2	L	E	S	L

2	Who	To Whom	What	How
0	T	A	V	T
1	F	M	S	F
2	L	E	S	L

3	Who	To Whom	What	How
0	T	A	V	T
1	F	M	S	F
2	L	E	S	L

4	Who	To Whom	What	How
0	T	A	V	T
1	F	M	S	F
2	L	E	S	L

5	Who	To Whom	What	How
0	T	A	V	T
1	F	M	S	F
2	L	E	S	L

6	Who	To Whom	What	How
0	T	A	V	T
1	F	M	S	F
2	L	E	S	L

7	Who	To Whom	What	How
0	T	A	V	T
1	F	M	S	F
2	L	E	S	L

8	Who	To Whom	What	How
0	T	A	V	T
1	F	M	S	F
2	L	E	S	L

Who/To Whom

<u>Code</u>	<u>Description</u>
T	Teacher
A	Adult
V	Volunteer
F	Female student
M	Male student
S	Small group
L	Large group
E	Everyone
O	Other student

What

<u>Code</u>	<u>Description</u>
1	Command
1Q	Direct question
2	Open-ended request
2Q	Clarifying question
3	Response
4	Instruction
5	Social comment
6	Task-related comment or action
7	Acknowledgement
8	Praise
9	Correction
10	Doesn't understand/No response
11	Encouragement/support
12	Observing/listening
X	Movement

How

<u>Code</u>	<u>Description</u>
Ta	Task relevance for the future
R/M	Math
B	Behavior
C	Corrective feedback
G	Guide
O	Organization
L	Laughter
W	Warmth, smiles
S	Specific
N	Negative
D	Demonstration or example
P	Positive expectations
I	Identify preferences
T	Touch
NV	Nonverbal

INTERACTION CODES

Who/To Whom	
Code	Description
T	Teacher
A	Adult
V	Volunteer
F	Female student
M	Male student
S	Small group
L	Large group
E	Everyone
O	Other student

What	
Code	Description
1	Command
1Q	Direct question
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3	Response
4	Instruction
5	Social comment
6	Task-related comment or action
7	Acknowledgement
8	Praise
9	Correction
10	Doesn't understand/No response
11	Encouragement/support
12	Observing/listening
X	Movement

How	
Code	Description
Ta	Task relevance for the future
R/M	Math
B	Behavior
C	Corrective feedback
G	Guide
O	Organization
L	Laughter
W	Work assigned
S	Specific
N	Negative
D	Demonstration or example
P	Positive expectations
I	Identify Preferences
T	Touch
NV	Nonverbal

INTERACTION SEQUENCE

A complete interaction sequence will take two or more frames and will show at least the initiation of the interaction and the response or lack of response to that initiation. An example of an interaction sequence is shown below.

1. Teacher: "John, shut the door."

20	Who	To Whom	What	How
(20)	(A) V	(T) A V	(1) (10) (2) (20) (3)	(T) C L N I
(A)	(P) M S	(P) M S	(4) (5) (6) (7) (8)	(M) G W O (T)
(C)	(L) E G	(L) E G	(9) (10) (11) (12) (13)	(B) O S P (V)

2. John: Walks to the door and shuts it.

21	Who	To Whom	What	How
(21)	(T) A V	(J) A V	(1) (10) (2) (20) (3)	(T) C L N I
(A)	(P) M S	(P) M S	(4) (5) (6) (7) (8)	(M) G W O (T)
(C)	(L) E G	(L) E G	(9) (10) (11) (12) (13)	(B) O S P (V)

3. Teacher: "Thank you, John."

22	Who	To Whom	What	How
(22)	(A) V	(T) A V	(1) (10) (2) (20) (3)	(T) C L N I
(A)	(P) M S	(P) M S	(4) (5) (6) (7) (8)	(M) G W O (T)
(C)	(L) E G	(L) E G	(9) (10) (11) (12) (13)	(B) O S P (V)

Interview Guide for High School Administrators

1. What is the socioeconomic composition of the student body at the school?
2. Has the student population changed in the past ten years? If so, how?
3. Does the school receive any special state or federal funding for math-related programs?
4. Is there a "school" grading policy? How much variation is there from one department to another? How does the grading policy in math courses compare to that in other courses?

☐ 5. What are the school rules on tardiness and absence?

☐ 6. What special problems have you encountered during the last year or two (e.g., teacher strikes, significant student problems, funding, competency tests).

☐ 7. What priority does the school put on math compared to other subjects?

☐ 8. Are there any special extra-curricular activities that are designed to increase students' interest in math, and how did these get started?

9. What percentage of the graduating seniors go to college? What colleges do they attend? Junior colleges, U.C. System, Private? Is this consistent with parent expectations?

Appendix B

SNAPSHOT AND FIVE-MINUTE INTERACTION OBSERVATION VARIABLES

WOMEN AND MATH TEACHER PROFILE SNAPSHOT VARIABLES

The following variables indicate all occurrence of a specific activity. These include students working independently or with the teacher.

Variable Number	Variable	Variable Description
S1	Teacher class manage/ no students:proportion of time	Total percentage of time teacher spends without students performing duties in the classroom (e.g., correcting papers, arranging books on a shelf).
S2	Total Silent Reading	Total percentage of time when students are reading silently. No written assignment is involved.
S3	Total Reading Aloud	Total percentage of time when students are reading aloud.
S4	Total Making Assignments	Total percentage of time students are being assigned classwork or homework.
S5	Total Instruction	Total percentage of time devoted to math instruction or explanation.
S6	Total Discussion	Total percentage of time students are discussing lecture materials, course work or reviewing assignments or problems.
S7	Total Practice Drill	Total percentage of time students are verbally involved in repetitive or rote work.
S8	Total Written Assignment	Total percentage of time when students are working silently on some type of written assignment, such as doing computation.
S9	Total Test Taking	Total percentage of time when students taking a test or quiz about the subject matter.

<u>Variable Number</u>	<u>Variable</u>	<u>Variable Description</u>
S10	Total Non-Math Instruction	Total percentage of time when students are involved in an academic activity whose primary emphasis is not math.
S11	Total Social Interaction	Total percentage of time students are socializing.
S12	Total Student Uninvolved	Total percentage of time students are not involved, neither academically nor socially.
S13	Total Discipline	Total percentage of time is devoted to the discipline of students.
S14	Total Classroom Management with Students	Total percentage of time students are involved in transitional activities, such as getting materials, putting away materials or sharpening pencils.

WOMEN AND MATH TEACHER PROFILE
FIVE-MINUTE INTERACTION VARIABLES

<u>Variable Number</u>	<u>Variable Description</u>
F10	All female student-initiated verbal interactions with teacher regarding math
F11	All male student-initiated verbal interactions with teacher regarding math
F15	All female student commands, requests and direct questions to teacher regarding math
F16	All male student commands, requests and direct questions to teacher regarding math
F18	All teacher commands, requests and direct questions to female students about math (which request a direct recall of previously learned materials, a yes/no answer or some other type of specific response)
F19	All teacher commands, requests and direct questions to male students about math (which request a direct recall of previously learned material, a yes/no answer or some other type of specific response)
F28	All occurrences of teacher asking female students if they understand or if the content makes sense regarding math (clarifying question)
F29	All occurrences of teacher asking male students if they understand or if the content makes sense regarding math (clarifying question)
F34	All female student volunteered answers to teacher's math-related question or command
F35	All male student volunteered answers to teacher's math-related question or command
F40	All teacher responses or compliance to a male student's question or command regarding math
F43	Teacher is instructing a female student in math
F44	Teacher is instructing a male student in math
F54	Amount of time teacher and female students are socially interacting
F55	Amount of time teacher and male students are socially interacting
F57	Amount of time the teacher must spend interacting with an outsider regarding summons, messages and the like

<u>Variable Number</u>	<u>Variable Description</u>
F58	Amount of time the teacher is not interacting with students, and is involved in classroom management
F62	All teacher acknowledgement and supportive comments to female students regarding math
F63	All teacher acknowledgement and supportive comments to male students regarding math
F65	All teacher praise of female students regarding math
F66	All teacher praise of female students regarding math
F74	Female students lack of response or compliance to teacher's question or command regarding math
F75	Male students lack of response or compliance to teacher's question or command regarding math
F80	All teacher encouragement of female students to try to solve a difficult problem or to help female students not be discouraged if a concept is not understood
F81	All teacher encouragement of male students to try to solve a difficult problem or to help male students not be discouraged if a concept is not understood
F83	Amount of time teacher spends observing students at work
F84	All teacher movement about the classroom
F85	Total amount of time devoted to math
F87	Total amount of time spent on correcting student's conduct in the classroom
F88	All teacher interactions with female students which focus on the relevance of math in future academic or career plans
F89	All teacher interactions with male students which focus on the relevance of math in future academic or career plans
F100	All types of teacher academic corrective feedback to female students. The corrective feedback code is used anytime the teacher is attempting to modify a female student's response regarding math
F101	All types of teacher academic corrective feedback to male students. The corrective feedback code is used anytime the teacher is attempting to modify a male student's response regarding math
F104	All teacher behavior which displays obvious expressions of happiness to a female student, such as laughing or smiling
F105	All teacher behavior which displays obvious expressions of happiness to a male student, such as laughing or smiling

<u>Variable Number</u>	<u>Variable Description</u>
F111	All teacher behaviors which are obvious displays of disapproval, punishment, sarcasm, threats or use of profanity towards female students
F112	All teacher behaviors which are obvious displays of disapproval, punishment, sarcasm, threats or use of profanity towards male students
F132	Teacher asks a math-related question of a female student and she either does not respond or states she does not know the answer. The teacher then rephrases the question and asks <u>another</u> student
F133	Teacher asks a math-related question of a male student and he either does not respond or states he does not know the answer. The teacher then rephrases the question and asks <u>another</u> student
F134	Female student asks teacher a math-related question and teacher responds with a question
F135	Male student asks teacher a math-related question and teacher responds with a question

Appendix C

STUDENT QUESTIONNAIRE VARIABLE NAMES AND SCALE COMPOSITION

STUDENT QUESTIONNAIRE VARIABLE NAMES

<u>Teacher/Counselor Factors</u>		<u>Scoring Code</u>
TakeCNL	Would take math from a not liked teacher	1 = yes 2 = no
PREFMFC	Prefer a male teacher	-1 = female 0 = no preference 1 = male
TalkTMTR	Talk to math teacher	0 = never 20 = lots
SRSFR	Rate teacher professional	10-40
SRSInd	Rate teacher personal attention	5-30
SRSFA	Rate teacher fair	1-5 5 = very fair
SRSEJ	Rate enjoying class	1-5 5 = enjoy always
RTINFLU	Teacher or counselor influence	0 = no influence 1 = influence
RLIKETHW	Likes younger teachers	0 = no 1 = yes
<u>Parent Factors</u>		
Parexpct	Parent expectations	1 = high school 2 = trade/business 3 = 2-year college 4 = 4-year college 5 = graduate school
PAMTALKM	Parents talk about taking math	0 = never 1 = once or twice 2 = several times
HelpHW	Parents help with math	0 = never 1 = once/week + 2 = once or twice/month 3 = 2 or 3/year
RFEELPAT	Father support for taking math	0 = no expectation or support 1 = yes, expectation or support
RFEELMOM	Mother support for taking math	0 = no support or expectation 1 = yes, support
EDMOTH	Education of mother	1 = LT high school 2 = high school 3 = some college 4 = college degree 5 = graduate
<u>Peer Factor</u>		
RKEEPPRS	Same class as friends important	0 = no 1 = yes
<u>Personal Factors</u>		
EDPLAN	Educational aspiration and career plans	0 = unsure 1 = high school or tech 2 = college +
ACH5	Geometry achievement test	0-30
SPACE	Spatial ability test	0-30
Did Take 1, 2	Took general math and algebra I	0 = no 1 = yes
RMATHANX	Math anxiety	0 = no 1 = yes
RCKSDiff	Difficulty with math	0 = no 1 = yes
RFeeling	Positive experience with math	0 = no 1 = yes

STUDENT QUESTIONNAIRE SCALE COMPOSITION

Scale Name	Scale Components
A. <u>Student Attitudes</u>	
1. Math anxiety	<u>Item 24</u>
	For each of the following items please indicate with a check whether you strongly agree, agree, disagree, or strongly disagree with the statement.
	● Having to do math makes me nervous. ● Sometimes I feel that I just can't learn math. ● I am afraid of math. ● If I really wanted to, I could learn enough math to be a scientist, an engineer, or a math teacher. * ● Mathematics is an interesting subject. *
2. Difficulty of courses	<u>Item 6</u>
	How <u>difficult</u> did you find the courses? Were they very difficult, quite difficult, or did you have little or no difficulty with them?
	● Calculus course ● General Math course
3. Feelings about teachers and courses	<u>Item 4</u>
	Think about math courses you have had so far in high school. For each course indicate your feelings, like or dislike, about the <u>teacher</u> who taught the course. (Do not make an entry for the course you are in now.)
	● Precalculus course

* These items weighted negatively in computing scale score.

Scale Name

Scale Components

3. Feelings
about
teachers and
courses
(cont.)

Item 5

Now tell us how you liked the course work for those classes you have checked above. Did you like the course very much, like it, dislike it, or dislike it very much?

- Precalculus course work
- Calculus course work

B. Students' Reasons
for Taking Math

1. Counselor
or teacher
influence

Item 3

Below are reasons you are, or are not, taking math next year in high school or college. Please show with a (✓) in the columns provided whether these reasons are very important, important, or not important.

3.1 I am taking math next year because:

9. My counselor advised me to.

10. My teacher suggested it.

2. Student
ability

Item 3 (See scale above)

3.1 I am taking math next year because:

3. I like math.

11. I get good grades in math.

C. Students' Reasons
for Not Taking
Math

1. Teacher or
counselor
advised
against it

Item 3 (See scale above)

3.2 I am not taking math next year because:

8. My teacher advised me not to.

9. My counselor advised me not to.

Scale Name	Scale Components
C. <u>Students' Reasons for Not Taking Math (Cont.)</u>	
2. Not important for college	<u>Item 3</u> (See scale above) 3.2 I am <u>not</u> taking math next year because: 4. It's not important for college.
3. Dislikes teacher	<u>Item 3</u> (See scale above) 3.2 I am <u>not</u> taking math next year because: 10. I don't like the teacher(s).
D. <u>Parental Influence</u>	
1. Father's feelings about math	<u>Item 16</u> The following statements refer to your mother's and father's feelings about math. For each statement check the appropriate columns for your mother and then your father. (For instance, if the statement is true of your mother, make a check in the 'yes' column under Mother; if the statement is not true of your father, make the check in the 'no' column under Father. If you don't know how they feel, or if the statement is not applicable, check the appropriate column.) ● Thinks mathematics is one of the most important subjects I've studied. ● Likes mathematics. ● Says he/she is "no good" in math. ● Thinks mathematics is as important for females as for males. ● Thinks I'll need mathematics to get a good job. ● Expects me to do well in math. ● Wants me to take advanced math. ● Is interested in my progress in math.

D. Parental
Influence
(Cont.)

2. Mother's
feelings
about math

Item 16 (See scale above)

- Thinks mathematics is one of the most important subjects I've studied.
- Likes mathematics.
- Says he/she is "no good" in math.
- Thinks mathematics is as important for females as for males.
- Thinks I'll need mathematics to get a good job.
- Expects me to do well in math.
- Wants me to take advanced math.
- Is interested in my progress in math.

E. Popular Men

1. Socially
adept

Item 20

In your school which of the following apply to boys and girls who seem to be popular? (If any of these is more important than the others, please put a double check)

- Goes to a lot of social functions (football games, dances, etc.).
- Runs for student office.
- Is a good organizer.

2. Good
looking

Item 20 (See item above)

- Is good looking,

F. Popular Women

1. Good
physical
appearance

Item 16 (See item above)

- Is good looking.
- Dresses well.

F. Popular Women
(Cont.)

2. Athletic and
outgoing

Item 16 (See item above)

- Is a good athlete.
- Runs for student office.

G. Keeping
Friendships

1. Comaraderie

Item 21

Thinking now of your friends, indicate with a check (✓) how important the following are in keeping your friendship going.

- Have fun when we're together.
- Can be honest with each other.
- Trust each other.

2. Schoolmates

Item 21 (See scale above)

- Go to the same school.
- Are together in some classes.

d. Characteristics
of Liked Teachers

1. Thorough and
professional

Item 9

In your opinion, what characteristics describe a math teacher you like and a math teacher you dislike. Check (✓) as many as you wish. Please put two checks (✓ ✓) next to any item you feel applies most strongly to a math teacher you like or dislike.

- Explains lessons clearly.
- Is fair.
- Is warm and friendly.
- Is well prepared.
- Is concerned with covering everything in the text.
- Gives extra help to students who need or want it.

H. Characteristics
of Liked Teachers
(Cont.)

2. Youthful and considers Homework load Item 9 (See scale above)
- Is young (under 35).
 - Gives lots of homework.
 - Gives little or no homework.

I. Characteristics
of Disliked
Teachers

1. Excessive workload Item 9 (See scale above)
- Gives extra work to students who need or want it.
 - Is concerned with covering everything in the text.
 - Asks lots of questions.
 - Gives lots of tests.
 - Is not young (over 35).
2. Encourages individual achievement Item 9 (See scale above)
- Gives a second chance to pass a test.
 - Encourages students to work individually.